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Focused Feasibility Study

Edina Well 7 Groundwater Contamination

STS Project 200804044

November 19, 2008

Prepared by:
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November 19, 2008

Mr. Nile Fellows
Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155

Re: Finalization of the Edina Groundwater VOC Contamination – Focused Feasibility Study; STS Project 200804044, Task 1001

Dear Mr. Fellows:

We are pleased to present you with the Edina Groundwater VOC Contamination – Focused Feasibility Study (FFS). The initial work was conducted as outlined in STS Proposal 200701405 submitted to the MPCA on June 29, 2007. After receiving comments from the MPCA (32 point review of the Draft FFS sent to STS by Nile Fellows via the August 13, 2008 e-mail), STS completed the FFS as part of a new Contract Work Order SFST0904 issued by MPCA on September 11, 2008.

This Focused Feasibility Study presents a systematic review of different options the City of Edina and other interested parties may consider:

- No Action, Monitoring (No Further Action – Continue Current Water Quality and Water Level Monitoring; Upgrade Monitoring System),
- Construction of additional municipal water supply wells / changing configuration of pumping / creation and maintenance of hydraulic barrier between St. Louis Park and Edina,
- Construction and operation of water treatment plant(s), and
- Purchasing water from neighboring cities, construction of interconnection mains.

These different options are analyzed, scored and a discussion is provided stressing the fact that a combination of the presented options would most likely be needed to provide a solution to maintaining Edina groundwater supply system and protecting the City's groundwater resource.

If you have any questions, please contact Peter Rzepecki at 763-315-6345 or Bob DeGroot at 763-315-6317.

Sincerely,

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Principal Engineer

PAR/dn
Encs.

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1.0 Executive Summary

Vinyl chloride contamination was detected in the City of Edina Municipal Well Number 7 (ED-7) beginning from 2000. This contamination resulted in removing ED-7 from production and triggered a multi-phase environmental investigation. The most important and relevant conclusions of this investigation are the following:

- Several Edina municipal wells, in addition to ED-7 (ED-2, ED-13 and ED-15), are also contaminated to a varying degree with volatile organic compounds (VOCs) – these contaminated wells are located in the northern area of the City of Edina and in St. Louis Park (see Figure 1).
- The data accumulated to date indicate that the VOC contamination detected in the Edina municipal wells may have originated within the boundaries of the City of St. Louis Park at numerous sources.
- Prairie du Chien – Jordan Aquifer (OPCJ) groundwater hydraulic gradient monitoring indicate that part of the time contaminated groundwater migrates from the St. Louis Park area south, toward Edina. Most if not all that groundwater is intercepted by ED-2, ED-13 and ED-15.

There is concern that more Edina municipal wells may be impacted if ED-2 exceeds the MCL and needs to be taken offline. That would result in a changed pumping scheme of the remaining municipal wells which may allow the VOC plume to be pulled further south.

The purpose of this Focused Feasibility Study (FFS) is to systematically evaluate a variety of measures that can be practically applied to protect the City of Edina groundwater supply system and the groundwater resource that the City depends upon for that supply. The main findings of this FFS are the following:

- Concentrations of chlorinated VOCs detected in ED-2, ED-13 and ED-15 show an increasing trend. ED-2 has the highest vinyl chloride levels of these wells and, if these trends continue, may soon exceed the MCL. Therefore, the City of Edina needs to evaluate options addressing the VOC exceedance which may be possible in another city well.
- Groundwater model predictive simulations indicate that ED-2, ED-13 and ED-15 intercept the VOC plume and prevent it from migrating further south. Such migration would likely occur if these wells were shut down. Pumping SLP-6 and/or Meadowbrook Golf Course Well would decrease VOC contaminant migration to ED-2. During periods of time when groundwater is migrating toward Edina, a combination of pumping from ED-2, ED-13, ED-15, SLP-6 and Meadowbrook Golf Course Well is needed to prevent VOC plume from migrating further south. However, ED-13 cannot be shut down – there is no other nearby well available to provide the needed “hydraulic barrier maintenance function” served by ED-13.
- Establishment of a systematic and long-term monitoring program is of essential importance. Upgrading the monitoring system is strongly recommended. Improved monitoring would allow better control, adjustments to and operation of the selected remedial action systems. It is important to establish a monitoring plan, identify responsibilities and sources of funding needed to implement the program.

- The following two options should be considered (in addition to operating the upgraded monitoring system and collecting monitoring data), if vinyl chloride concentrations detected in ED-2 exceed the MCL level:
  - Continue operating ED-2 and process the produced groundwater at a local/dedicated treatment plant (either upgrade the existing plant or construct a new plant).
  - Shut-down ED-2, start pumping from SLP-6 and Meadowbrook Well, and shift the ED-2 production to other wells, or supplement the lost production by purchasing water from neighboring cities.

Purchasing water from the neighboring municipalities represents only a partial solution since pumping from the contaminated wells would still need to be continued to maintain the hydraulic barrier and to protect the other Edina wells.

Other options would need to be implemented if VOC contaminants were detected at excessive concentrations in ED-13, ED-15 or in other wells. Either the contaminated water would need to be treated or the production shifted to other wells.

The City of Edina should have a treatment plant ready to process VOC contaminated groundwater. Alternatively, shutting down ED-2 would necessitate pumping from SLP-6 / Meadowbrook Well to maintain a hydraulic barrier to intercept the contaminated groundwater.

2.0 General Information

2.1 Problem Statement, Purpose of Focused Feasibility Study

Vinyl chloride contamination was detected in the City of Edina Municipal Well Number 7 (ED-7) beginning from 2000. This contamination resulted in removing ED-7 from production and triggered a multi-phase environmental investigation. The most important and relevant conclusions of this investigation include the following:

- Several Edina municipal wells, in addition to ED-7 (ED-2, ED-13 and ED-15), are also contaminated to a varying degree with volatile organic compounds (VOCs) – these contaminated wells are located in the northern area of the City of Edina and in St. Louis Park (see Figure 1).
- The data accumulated to date indicate that the VOC contamination in the Edina municipal wells may have originated within the boundaries of the City of St. Louis Park at numerous sources.
- Prairie du Chien – Jordan Aquifer (OPCJ) groundwater hydraulic gradient monitoring indicate that part of the time contaminated groundwater migrates from the St. Louis Park area south, toward Edina.

There is a concern that a large groundwater VOC plume in OPCJ Aquifer extending over the St. Louis Park and northern area of Edina may further impact the City of Edina groundwater supply system. The purpose of this Focused Feasibility Study (FFS) is to systematically evaluate a variety of measures that can be practically applied to protect the City of Edina groundwater supply system and the groundwater resource that the City depends upon.

2.2 Site Description / Location

The area of concern evaluated by this report covers the entire area of the City of Edina. However, because the groundwater system supplying water to the City of Edina extends beyond the boundaries of the City, the area of concern also includes the adjacent parts of the City of St. Louis Park to the north of Edina and the City of Hopkins and the City of Minnetonka to the west and northwest of Edina (see Figure 1). The predominant land use within these areas is residential neighborhoods, but some sections of the land are developed as commercial and industrial areas – particularly within the City of St. Louis Park and Hopkins. Parks, golf courses and small lakes occupy minor portions of the land (see Figure 2).

2.3 Site Characterization (Geology, Hydrogeology, Groundwater Contamination)

2.3.1 Regional Geology / Hydrogeology

The City of Edina pumps groundwater from the Prairie du Chien – Jordan (OPCJ) aquifer system. This aquifer, which is the main groundwater producer in the Twin Cities metropolitan area, is part of a larger groundwater system where groundwater is circulating through several geological strata briefly described below.

Drift Formation

The shallowest geological formation that constitutes ground surface of the project area is the Drift formation. It represents a complex system of water table and confined sand aquifers separated by a glacial till and other lower permeability strata. This quaternary hydrogeology is also described as the water-table system and buried glacial aquifer (this last one present mainly in the western portion of Hennepin County - Kanivetsky, 1989). Five hydro-stratigraphic units have been described near the Reilly Tar Site in St. Louis Park: Upper Drift Aquifer, Upper Confining Unit, Middle Drift Aquifer, Lower Confining Unit, and Lower Drift Aquifer (Lindgren, 1995).

A network of glacial drift filled, “buried bedrock valleys” is present in the area. One prominent bedrock valley is east of the project area, running south-north through Lake Harriet - "Chain of the Lakes". Another valley runs through Edina, roughly following Nine Mile Creek. Both of these valleys join the major, east-west running regional buried bedrock valley that is present south of Highway I-494. All these valleys dissect bedrock formations all the way down to the Prairie du Chien – Jordan. One smaller branch that dissects the Platteville and Glenwood formations is present in the southern part of St. Louis Park, near northern Edina. These buried valleys, which dissected through regional aquitards, provide pathways for shallow groundwater that flows into and recharges deeper aquifers, including St. Peter and Prairie du Chien – Jordan, the most important aquifer in the region.

Decorah-Platteville-Glenwood

The Drift formation overlies the Decorah-Platteville-Glenwood formations. Although the Platteville Limestone is regionally considered part of the confining unit, it yields water to wells in the project area and is locally considered to act as an aquifer. Studies of the Platteville Formation under shallow bedrock conditions demonstrated the presence of discrete intervals with relatively well developed secondary porosity, separated by intervals with much lower porosity (Runkel et al., 2003).

The Decorah Shale has been extensively weathered, eroded and reduced to rubble. The Glenwood Shale is consistently present throughout much of the project area and constitutes a confining unit. This regional confining unit is dissected by erosion where buried bedrock valleys are present.

St. Peter Sandstone

The St. Peter Sandstone constitutes the next deeper regional aquifer. It is present throughout most of the southeast portion of Hennepin County including the project area. It is missing east of the project area where it was eroded away along the course of the buried bedrock valley (running south-north through Lake Harriet - "Chain of the Lakes"). The bedrock valleys were subsequently filled with glacial drift.

The St. Peter Sandstone is composed of well sorted, fine- to medium-grained quartzose sandstone. Several indicators for the St. Peter aquifer in shallow bedrock conditions suggest that fracture flow may be regionally significant. Fractures in the St. Peter Sandstone are known to at least locally provide conduits through which groundwater can move much more rapidly than rates predicted under the assumption of inter-granular flow only (Runkel et al., 2003).

The basal portion of the St. Peter represents a confining unit, which consists of 5 to 15 feet of siltstone and shale. This confining unit overlies the OPCJ aquifer, which (as discussed in the following section) consists of dolomite and sandstone.

Prairie du Chien / Jordan Aquifer System (OPCJ)

Some investigators have recently postulated that the OPCJ aquifer should be divided into a Shakopee Aquifer (upper member of the Prairie du Chien Group) and Jordan Aquifer with Oneota Dolomite (the lower member of the Prairie du Chien Group, particularly the lower portion of it) serving as a confining unit. Groundwater flows through the Shakopee Aquifer and the top portion of the Oneota Dolomite chiefly through fractures and solution features having moderate to extremely high values of hydraulic conductivity. This migration pattern is quite different from groundwater flow within the Jordan Sandstone (Runkel et al., 2003). However, most of the Prairie du Chien and Jordan wells within the project area are opened to both of these aquifers, providing hydraulic connection between them. Since most of the wells are opened to most or the entire OPCJ formation, there is no data to compare water levels and vertical hydraulic gradients between the Shakopee and Jordan Aquifers. However, vertical flow rate measurements conducted in the Edina OPCJ Test Well (MN Unique No. 748656) indicate a strong downward movement of groundwater from Prairie du Chien to Jordan formation (well logging conducted by Robert G. Tipping of the Minnesota Geological Survey – see STS, 2008a).

Groundwater Flow Directions, Gradients and Water Level Fluctuations

On a regional scale (southeastern part of Hennepin County), groundwater in the OPCJ aquifer flows predominantly in the eastern, southeastern and southern direction, towards the Mississippi and Minnesota Rivers.

Recharge to the OPCJ aquifer system occurs as leakage from the overlying bedrock units and from the glacial drift where the OPCJ formation sub-crops beneath it where the buried bedrock valleys are present. Part of the OPCJ aquifer groundwater discharges to surface water bodies - primarily to the major river systems that physically dissect the aquifer (i.e., the Mississippi and Minnesota Rivers). Groundwater from this aquifer system is also discharged through groundwater pumping. Leakage through the underlying St. Lawrence Formation, a regional confining unit, is considered negligible.

Comparison of the average water levels in the four bedrock aquifers (Drift, Platteville, St. Peter and OPCJ) clearly demonstrates the presence of consistent downward vertical gradients from shallow to deeper aquifers. The greatest difference in water levels exists between the St. Peter and OPCJ aquifers. To a large extent, these head differences are caused by extensive pumping from the OPCJ aquifer and the relatively low hydraulic conductivity of the Basal St. Peter confining unit. The second strongest vertical gradient or head difference is present between the

Platteville and St. Peter aquifers. This gradient is also caused by pumping from the underlying OPCJ aquifer (which, despite the presence of the Basal St. Peter confining unit, lowers water level in the St. Peter aquifer), and by the presence of the relatively impermeable confining Glenwood Shale. Water levels in the Platteville wells are only slightly lower compared to water levels in the Drift aquifer wells. These two shallowest aquifer systems are in much closer hydraulic communication than with deeper aquifers.

The greatest fluctuations in water levels can be observed in the OPCJ wells – maximum fluctuation was recorded in St. Louis Park Municipal Well No. 10 (SLP10) – 71.40 feet. Water levels in the other OPCJ wells, some distance from pumping centers, fluctuate on the order of 30 to 40 feet (see STS, 2008a). All hydrographs constructed for OPCJ wells show remarkable correlation (STS, 2006c).

Continuous water level monitoring conducted for some time in ED-7, ED OPCJ Test Well and Meadowbrook Golf Course Well shows a strong pattern of seasonal groundwater level fluctuations in the OPCJ aquifer, with water levels dropping during summer time 40 feet below the levels characteristic for winter time (STS, 2008a). This continuous water level monitoring also revealed a pattern of frequently changing OPCJ groundwater flow direction across the boundary between St. Louis Park and Edina. Although most of the time groundwater flows away from Edina, monitoring in 2007 showed that during a period from mid-September to mid-November (two months), groundwater was flowing from southern St. Louis Park toward the northeast part of Edina (STS, 2008a).

2.3.2 Groundwater Contamination

<u>VOC Contamination</u>

A large VOC plume exists over a portion of St. Louis Park and extends to the northern portions of Edina and is contaminating several high capacity wells in the northern part of Edina, ED-2, ED-7 (that well was shut down in 2004), ED-13, ED-15 and Edina Country Club Well. Concentrations of chlorinated VOCs detected in ED-2, ED-13 and ED-15 show an increasing trend of VOC contamination. Contamination of ED-2 and ED-13 appear to be of greatest concern as concentrations of vinyl chloride detected in these high-production municipal wells in May of 2008, 1.4 μg/L (ED-2) and 0.6 μg/L (ED-13), are approaching a federal drinking water standard, MCL (2 μg/L) (see STS, 2008b).

<u>PAH Contamination</u>

A large polyaromatic hydrocarbon (PAH) plume exists in aquifers over a large portion of St. Louis Park. PAH contamination is associated with industrial activities at the former Reilly Tar Site, St. Louis Park. The PAH plume within the OPCJ aquifer coincides, to a large extent, with the VOC plume. Very low levels of PAH contamination has been detected in ED-13. Monitoring data indicate that the PAH plume is not significantly expanding (see Annual Monitoring Reports prepared by ENSR – these reports are available at MPCA and at the archives of the City of St. Louis Park). Nonetheless, its presence should be kept in mind while analyzing remedial options for controlling the VOC contamination in the OPCJ aquifer.

2.3.3 Implications for VOC Contaminant Migration from St. Louis Park into Edina

There are many indicators that the OPCJ groundwater in the project area moves along preferential pathways (in the form of solution openings and fractures along bedding planes, etc.). It is likely that these "groundwater preferential pathway channels" are characterized by very high hydraulic conductivity values. Consequently, there is a potential that during periods of time like September – November of 2007, the groundwater dissolved contaminants may be moving fast and considerable distances into Edina. During groundwater flow direction reversals, not all contaminants travel back and away from Edina - some are left in place, entrained in the rock pores and fractures and adsorbed to mineral grains of the aquifer's rock formation. These trace amounts of contaminants continue their migration further into Edina's interior during consecutive periods of groundwater flow toward Edina. The net effect is a gradual dissipation and expansion of the plume into Edina.

2.4 Past Site Investigations

The reports documenting the findings of the Edina ED-7 contamination study considered in this FFS are available in the Minnesota Pollution Control Agency's (MPCA) archives:

- City of Edina Well No. 7 Study - Preliminary Data Report (STS, March 2005)
- City of Edina Well No. 7 Study - Phase II Report (STS, June 2005)
- City of Edina Well No. 7 Study - Phase III Report (STS, June 2006a)
- St. Louis Park W437 Chlorinated Solvent Source Investigation (STS, March 2006)
- Construction and Testing of the Edina OPCJ Test Well (STS, June 2007a)
- St. Louis Park / Edina / Hopkins Groundwater VOC Contamination Study 2006 / 2007 (STS, June 2007b)

The multi-stage Reilly Tar Site / Meadowbrook groundwater modeling project is also related to the study of the VOC plume in the area of Edina, St. Louis Park and Hopkins. The most up-to-date reports summarizing this project (also available at the MPCA archives) are:

- Reilly Tar Site / Meadowbrook Groundwater Model Expansion (STS, June 2006b)
- Hydrogeological Analysis for 3rd Five Year Review – Reilly Tar & Chemical Corporation Superfund Site (STS, August 2006)

New water level and VOC water contamination data has been accumulated, and groundwater modeling has been done during a period of time from July 1, 2007 to June 30, 2008. These activities, collected data and obtained results are summarized and documented in the following three letter reports:

- Monitoring and Testing of the three OPCJ Wells: Edina Well No. 7, Edina Test Well and Meadowbrook Golf Course Well – Letter Report (STS, June 30, 2008a)

- Edina Groundwater Contamination Study - Groundwater VOC Data Review, VOC Database Maintenance, Analysis of Trends – Letter Report (STS, June 30, 2008b)
- Update to the Reilly Tar / Meadowbrook Groundwater Model – Letter Report (STS, June 30, 2008c)

2.5 Scope

This Focused Feasibility Study (FFS) describes the potential hazards associated with the existing OPCJ groundwater contamination and evaluates in a systematic manner the following alternative response actions judged to be the most relevant and feasible:

- No Action – Continue Existing Groundwater Quality and Water Level Monitoring Program
- Upgrading Monitoring System – Construction of Additional OPCJ Monitoring Wells
- Construction of Additional Municipal Water Supply Wells / Change Configuration of Pumping / Creation and Maintenance of Hydraulic Barrier between St. Louis Park and Edina
- Purchasing of Water from Neighboring Cities, Construction of Interconnection Mains
- Construction and Operation of Water Treatment Plant

These alternative response actions are evaluated considering all the available information and then compared and ranked using the following criteria:

- Overall Protection of Human Health and the Environment – Threshold Criterion
- Compliance with ARARs
- Long-term Effectiveness and Performance
- Reduction of Toxicity, Mobility, or Volume (TMV) Through Treatment
- Implementability
- Short-term Risks
- Estimated Costs and Schedule
- State Acceptance
- Community Acceptance

2.6 Stakeholders and Points of Contact

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3.0 Edina Groundwater Supply System Overview

The City of Edina owns and operates the local water distribution system consisting of 18 production wells, four water treatment plants, one below-ground storage reservoir, four elevated storage tanks, and an advanced network of watermain which spans throughout the City (see Figures 1 and 3). Each of the 18 wells has been placed in unique locations throughout the City for the purpose of appropriating a volume of groundwater necessary to meet the demand of the residents and businesses in the community. The majority of the consumers are supplied water through the use of these 18 wells which range in depth from 380 to 1080 feet. Most wells are completed in the Prairie du Chien – Jordan aquifer system (OPCJ); three of them (ED-9, ED-10 and ED-12) are completed in a deep Mt. Simon aquifer (CMTS). A number of Edina residents are supplied water from an adjacent municipality. The City of Edina maintains ownership of the infrastructure (watermain), but the water is supplied by a separate system. The Morningside neighborhood is supplied water from the City of Minneapolis, and a number of commercial properties along the south and southwest limits of Edina are supplied water from the cities of Bloomington and Eden Prairie, respectively.

Three of the 18 wells (ED-9, ED-14, and ED-17) are operated with limited use. These wells supply approximately 8.3% of the City's total water supply. Elevated levels of radium at these well locations have resulted in the need to scale back production of water from these source points. Wells ED-9, ED-14, and ED-17 are unfiltered sources of water, and rely completely on the blending and dissolution method for reduction of radium concentrations in the water. Well No. 7 is currently inactive due to elevated concentrations of vinyl chlorides. In total, 7 of the 14 readily used wells supply water to the City's treatment facilities for treatment by oxidation and filtration. The other 7 provide unfiltered water and are considered "seasonal" wells utilized during the high-demand times of the year. The construction of a new well (ED- 20) is on-going and is anticipated to be brought on-line by the end of the 2008. This well is anticipated to take the place of the inactive and limited use wells.

The storage capabilities for the City's system include a 4 million gallon underground storage reservoir and 3 million gallons of storage in the elevated tanks. The storage facilities are used for the delivery of water during peak flow events and in emergency situations. The elevated storage facilities provide and maintain the water system pressure which is unique to each area of the City. The water delivered to the storage facilities is water which has been treated at the treatment facilities.

The dynamics of Edina's treatment facilities include treatment of groundwater by filtration and chemical oxidation. The need to conduct treatment is due largely to the high concentrations of naturally occurring iron in the source water, and the scaling of oxidized iron deposited along the walls of the unlined cast iron pipes. The naturally occurring iron is removed by means of a filtration media maintained at each of the treatment facilities. Each treatment facility has recently undertaken considerable rehabilitation work. In addition, a phosphate solution is injected into the water supply to coat the unlined cast iron pipes. The coating is to help prevent the scaling of iron deposits along the unlined cast iron pipe walls caused by the friction forces of moving water. Chemical treatment in the form or potassium permanganate and manganese oxide is injected to allow for the iron and manganese to precipitate out of solution, and be caught within the filter media. Treatment plants No. 3 and No. 4 provide treatment per this method for the source water appropriated from wells ED-10, ED-11, ED-12, and ED-13.

Radium is treated by means of a hydrous manganese oxide (HMO) technique. The HMO is an adsorbent type treatment that removes radium by the precipitation and filtration process. Edina does not provide water softening of the source water. Water hardness ranges from 16 to 17 grains per gallon (291 mg/l).

Water is supplied to the City of Edina by means of the City's underground infrastructure system consisting of cast iron, ductile iron, and polyvinyl chloride (PVC) pipes. The pipes serve as transmission lines to the delivery points of the system; namely the homes and businesses within the community. Pipes range in size from 4-inches to 16-inches in diameter, and extend across the City primarily within the road right-of-way. Additional systems include the Supervisory Control and Data Acquisition (SCADA) system which automates the operation of the water distribution system, and provides electronic data and communication capabilities for the City operators.

Customary to all municipalities, the City of Edina has prepared a Capital Improvement Plan (CIP) and a Water Supply Plan specific to the current and future needs of the City's water supply and distribution system. The CIP identifies new wells, treatment facilities and future infrastructure improvements necessary to meet the present and future needs of the consumers. The water supply plan addresses system capabilities and needs based on projected growth and redevelopment within the City.

3.1 Existing System Details

The 18 City wells draw water from the Mount Simon and Prairie Du Chien-Jordan aquifers. At the present time, three of the 18 wells have been taken out of operation for reasons described previously in this report. The 15 active wells are and have been able to supply enough water to meet the City's average daily demand (AD) of approximately 7.6 million gallons per day (MGD). The City has been able to meet the seasonal demand on account of recent well rehabilitation work, utilization of the underground storage reservoir, and change in the pumping configurations of the other wells.

The elevated storage facilities were located and designed specific to the operating pressure desired by the consumers. Edina operates off of a single pressure zone with an overflow elevation at 1086 feet, and a corresponding ground service elevation range of 825 to 1000 feet. The minimum and maximum water pressures are 35 psi and 113 psi, respectively. The operating pressure of Edina's distribution system is considerably higher than the operating pressure(s) of adjacent municipal systems. The water pressure issue must be carefully evaluated when considering alternatives for remedial action, specifically when interconnecting with one or multiple municipal systems.

3.2 Existing System Controls and Operations

Detections of vinyl chloride in well ED-7 and the presence of radium in wells ED-9, ED-14, and ED-17 have required the City of Edina to reconfigure the production (pumping rate) for the other 14 wells. Wells ED-7, ED-9, ED-14, and ED-17 are identified as “seasonal” wells and are used primarily for the production of water during peak flow times of the day (year); typically during the growing season. Edina has voluntarily taken well ED-7 out of operation until a corrective action plan can be developed and implemented to remove or lower the concentrations of vinyl chloride to below drinking water standards. Wells ED-9, ED-14, and ED-17 are operated with limited use, and contribute very little water to the overall water supply.

Water appropriated from City wells ED-2, ED-4, ED-6, ED-10, ED-11, ED-12, and ED-13 is treated by filtration and chemical oxidation at the treatment facilities, and provide the primary source of potable water. Wells ED-3, ED-5, ED-8, ED-15, ED-16, ED-18, and ED-19 are unfiltered sources of water which provide water to the system as the demand for water increases. The City has relied on the blending and dissolution effects of mixing the filtered and unfiltered water to meet the aesthetic value, and regulatory requirements associated with drinking water. The operation and control of the wells and water distribution system is handled and monitored by the City’s Supervisory Control and Data Acquisition (SCADA) system. Each well and treatment facility is automated and monitored with the use of the SCADA system. Reports are generated as deemed necessary by system operators.

4.0 Screening of Alternative Response Actions

4.1 No Action

Health Risk Hazard from Contact with Contaminated Groundwater

The focus of this FFS is the VOC contaminated groundwater that the City of Edina is pumping from the OPCJ aquifer for its water supply system. Sampling of Edina's private water supply wells showed that these wells (completed in Drift, Platteville, St. Peter and the top portion of the Prairie du Chien aquifers) are VOC contaminant free (STS, 2005a). Because the OPCJ aquifer is deep under the ground surface, the only direct human contact with contaminated groundwater is through the Edina water supply system.

Contaminant concentrations measured in water samples collected from municipal wells typically change gradually over time. Since the Edina water supply municipal wells are subject to periodical sampling and water quality monitoring, it is unlikely that significantly contaminated groundwater would be allowed to enter the water supply system. Drinking water criteria are developed based on long-term, chronic human exposure to contaminant. Frequent monitoring of water quality in Edina municipal wells is of critical importance under these circumstances.

Concentrations of vinyl chloride measured in Edina municipal wells ED-2, ED-13 and ED-15 are showing an increasing trend and are approaching the Federal drinking water standard – MCL (Maximum Contaminant Level). Vinyl chloride concentration measured in a groundwater sample collected from ED-2 on May 1, 2008 is 1.4 ug/L (vs. MCL = 2 ug/L) (STS, 2008b). However, two consecutive detections of contaminant concentration in a given well in excess of a drinking water criterion will necessitate the well shut-down.

Contaminated groundwater is unlikely to pose any significant hazard / risk to human health because of the regulatory procedures in place. The only likely hazards are those associated with a decreased water supply and the following inconveniences and economic losses. These hazards are discussed in the following subsection.

Potential Consequences of Water Supply Shortages Caused by
Expansion of VOC Plume and Forced Closures of Edina Municipal Wells

The City of Edina shut down groundwater production from ED-7 in 2004, after the concentrations of vinyl chloride detected in the samples collected in that well exceeded the Federal drinking water criteria. A severe shortage in water supply may result if more of the Edina high production municipal wells are shut down due to VOC contamination. As previously discussed, Reilly Tar Site / Meadowbrook Groundwater Model was updated for evaluation of the City of Edina's well field and its interaction with the major VOC plume present in the area in the OPCJ aquifer system. Results of the model predictive simulations (STS, 2008c) correspond to the results of groundwater quality monitoring. The model predicts that under current pumping configuration, the VOC plume is intercepted by ED-2, ED-13 and ED-15. Vinyl chloride concentrations measured in ED-2 are approaching Federal drinking water standards. If the standard is exceeded, ED-2 will need to be shut down (or its water treated). Such shut down may result in:

- The need to increase the production from seasonal wells (unfiltered water)
- The need to increase production from non-seasonal wells
- The need for new wells and treatment facilities
- Migration of VOC plume further south
- The need to shut down more municipal wells affected by southward migrating VOC plume

Other active wells (seasonal and non-seasonal) will be required to produce more water to make up the loss in production as the plume expands and additional wells are impacted. The concerns associated with such a situation are outlined below.

- Wear and Failure of Pumping Equipment
- Higher Volume of Unfiltered Source Water
- Yield Capabilities of the Aquifer

An increase in production (pumping) of these wells, at rates near or above the maximum production capabilities, can cause the pump and motor to wear out much faster and ultimately fail. The need for replacement of pumping equipment is the end result, and very costly to the City. Most systems are designed with a maximum production capability, but are operated at a lower “Optimum” production rate. A higher pumping rate for the remaining unimpacted wells will also have an effect on the hydraulic gradient of the aquifer. The change in gradient can draw the plume closer to the active wells at a faster rate, limiting the City’s response time for corrective action. Another concern is the increase in production of the “Seasonal” wells. Edina has relied on the blending and mixing of filtered (treated) and unfiltered source water to achieve a water supply that meets regulatory drinking water standards. To date the method has proven to be effective. The need to produce more water from the seasonal wells results in higher volumes of unfiltered water entering the distribution system. The unfiltered water may be of such volume that dissolution with the filtered water is no longer effective. Radium and iron concentrations increase as a result. Lastly, the pumping of the wells can have exhausting effects on the aquifer to a point where the yield is jeopardized.

4.2 Alternative Response Actions

4.2.1 No Further Action – Continue Current Water Quality and Water Level Monitoring

Evaluating No Further Action is a requirement of the FS process and provides a baseline from which to compare Response Action Alternatives.

Currently two types of monitoring activities are taking place that collect information relevant to this FFS study.

ENSR, an environmental consultant working for the City of St. Louis Park, periodically collects groundwater samples from an extensive network of monitoring wells in the St. Louis Park, Edina and Hopkins area. MPCA splits the ENSR collected samples and delivers them to the MDH laboratory for low-level VOC analysis.

STS, in cooperation with MDH, is conducting continuous water level monitoring at three OPCJ wells located in the important area around the boundary between St. Louis Park and Edina: ED-7, ED OPCJ Test Well (ED Test Well) and Meadowbrook Golf Course Well (Meadowbrook Well).

Monitoring groundwater quality and groundwater levels, both provide data for monitoring the expansion of the VOC plume that can potentially impact the City of Edina water supply system. ENSR also monitors the PAH plume – however this plume appears to be currently of a lesser concern to the City of Edina, compared to VOC plume. However, the PAH data should be reviewed with regard to the potential impact of the PAH plume upon the Edina municipal wells.

4.2.2 Upgrade Monitoring System – Install Additional Deep Monitoring Wells

The existing monitoring system and activities could be expanded and improved upon to allow better monitoring of groundwater flow direction and evolution of the OPCJ aquifer contaminant plume that is encroaching upon Edina. The collected data from such improved monitoring system would assist in making a more informed remedial action decision.

The proposed elements of an improved monitoring system discussed in Section 5.2 include the following:

- installation of additional OPCJ monitoring wells;
- expansion of a program of continuous monitoring of water level; and
- expansion of a program of well sampling for VOC analysis.

4.2.3 Remedial Options

Consideration of the first option discussed in Section 4.2.1, “No Further Action – Continue Current Water Quality and Water Level Monitoring” is based on the assumption that a combination of current groundwater production activities and a natural attenuation will result in a gradual improvement of groundwater quality, or at least will prevent further degradation of the Edina water resources.

However, the results of groundwater level monitoring (STS, 2008a), groundwater quality monitoring (STS, 2008b) and groundwater model predictive simulations (STS, 2008c) point to the fact that the City of Edina is faced with a need to prepare some remedial actions to protect its water supply system and resources.

The remedial actions evaluated within this study are those that are considered feasible from an engineering perspective and correspond to the City of Edina's needs and growth plans. STS met with the City of Edina's Public Works staff to review plans and gather information concerning current system operations, well locations, water supply plans, and current and future capital improvement projects. STS utilized this information during selection of remedial options for analysis/evaluation. The three groups of active remedial actions evaluated in this FFS and discussed in more detail in Sections 5.3, 5.4 and 5.5 include:

- Construction of additional municipal water supply wells / changing configuration of pumping / creation and maintenance of hydraulic barrier between St. Louis Park and Edina;
- Construction and operation of water treatment plant(s); and
- Purchasing water from neighboring cities, construction of interconnection mains.

These three groups of remedial options are presented in order of increasing magnitude of engineering and complexity associated with their implementation, operation and maintenance.

5.0 Detailed Description of the Most Feasible Alternative Response Actions

5.1 No Action – Continue Groundwater Quality And Water Level Monitoring

5.1.1 Description

ENSR, an environmental consultant working for the City of St. Louis Park, periodically collects groundwater samples from an extensive network of monitoring wells in the St. Louis Park, Edina and Hopkins area. This sampling work is part of an ongoing monitoring effort associated with the Reilly Tar Superfund Site. The samples are analyzed for polyaromatic hydrocarbons (PAH). Since 2005, once a year, the MPCA has been obtaining groundwater samples for low-level VOC analysis by splitting samples collected by ENSR. Low-level VOC analyses are conducted by the MDH laboratory. The cost of additional time for ENSR to collect VOC samples has been paid by the City of St. Louis Park.

The monitoring network sampled by ENSR includes several St. Louis Park and Edina OPCJ wells producing monitoring data of importance for the City of Edina. The wells that are important for monitoring of VOC plume expansion toward Edina include: W48 (Methodist Hospital Well – quarterly monitoring), SLP-4 (annual monitoring), SLP-6 (quarterly monitoring), ED-2 (annual monitoring), ED-3 (annual monitoring), ED-7 (annual monitoring), ED-13 (annual monitoring), ED-15 (annual monitoring), W119 (Meadowbrook Golf Course Well - quarterly monitoring) and W-401 (annual monitoring).

It is important to monitor the evolution of VOC plume in the Prairie du Chien aquifer. That plume centered in the St. Louis Park area is encroaching upon the City of Edina and, thus, impacting the City's water supply resources. It is also important to monitor the Edina municipal wells not yet impacted by VOC that are located south of the plume. The following wells are recommended to be sampled annually for low-level VOC analysis:

List of Wells to be Annually Sampled for Low-Level VOC Analysis

Well Name	Well Name
ED-2	SLP4
ED-3	SLP-6
ED-4	W23
ED-6	W33
ED-7 (not sampled since 2005)	W48
ED-13	W119
ED-15	W401
ED-16	W402
ED-17	W403
ED OPCJ Test Well (ED-TEST)	W406
Hopkins 6	

STS in cooperation with MDH has been conducting continuous water level monitoring at three OPCJ wells located in the important area around the boundary between St. Louis Park and Edina: ED-7, ED-TEST and W119. This monitoring produced highly valuable data (STS, 2008a) for evaluation of groundwater flow direction between the cities and was used to update the groundwater model (STS, 2008c). That updated and recalibrated model was used to evaluate remedial action scenarios/options discussed in Sections 5.3 and 5.4.

Continuous water level monitoring in these three wells (ED-7, ED-TEST, W119) should be continued.

5.1.2 System Options

Information gathered from the groundwater quality and water level monitoring program has been useful in evaluating dissolved phase contaminant migration scenarios. Continued collection of these data will be important to evaluate long term fate and transport of the plume.

5.1.3 Benefits/Impacts

Continuation of the current minimum monitoring program is important for evaluation of the contaminant plume evolution and changing impacts upon the City of Edina water resource.

5.1.4 Needs

At this time there are no provisions for continued groundwater monitoring for VOCs. It is suggested that a continuous monitoring program be implemented with at least once a year sampling.

5.1.5 Limitations/Constraints

Not all OPCJ wells in northern Edina are part of the groundwater quality monitoring network. Location of the southern boundary of the VOC plume is not exactly known or monitored with sufficient accuracy - a larger number of monitoring wells would be required. Additional attempts should be made to identify and sample OPCJ wells in the Northern Part of Edina.

The three wells that are part of the continuous water level monitoring are not ideally positioned to monitor hydraulic gradient and groundwater flow direction around the boundary between St. Louis Park and Edina.

These considerations are further addressed in Section 5.2

5.1.6 Timeline

The monitoring program should be evaluated periodically as to continuance and adequate coverage.

5.1.7 Cost

The City of St. Louis Park is required to sample its well network for PAH contamination because of the presence of the Reilly Tar superfund site. The ability in the past to periodically coordinate collection of VOC samples at the same time as PAH sampling is taking place has allowed for a reduction of efforts and costs. Other costs have included analysis, VOC database maintenance and reporting. Continued cooperation between the MPCA and City of St. Louis Park is required to maintain this arrangement. In case this arrangement is found not to be working, the MPCA may need to determine other means of collecting VOC samples.

Continuation of water level monitoring in three wells will involve limited cost of maintenance of transducers/dataloggers, periodic (once every two to three months) trips to the field to check on the transducers/dataloggers operation, downloading data, processing water level data and presenting it once a year in a letter report.

5.2 Upgrading Monitoring System – Construction of Additional Monitoring Wells

5.2.1 Description

The Edina Test Well is not part of the ENSR monitoring program. That well should be sampled – minimum once a year.

Consideration should be given to installing more OPCJ aquifer monitoring wells in the northern part of Edina to allow for improved detection of the southern part of the VOC plume and hydraulic gradients in that area. Monitoring ED-2 and ED-15 may not be enough to detect a VOC plume's advancement toward the planned ED-21. Pumping from ED-21 might induce VOC plume movement through an area between ED-2 and ED-15. A similar situation might have developed when ED-7 pulled VOC contaminants from the north.

The three wells that are part of the continuous water level monitoring are not ideally positioned to monitor hydraulic gradient and groundwater flow direction around the boundary between St. Louis Park and Edina.

It is recommended that two new OPCJ monitoring wells are constructed at Todd Park and Browndale Park near the Minnehaha Creek – these locations were suggested by the representatives of the City of Edina. These two wells would be added to the existing three wells, ED-7, ED Test Well and Meadowbrook Well, as a network of wells for monitoring groundwater quality and gradients in the important area around the boundary between St. Louis Park and Edina. These five wells should be sampled for VOC once a year and each of them should be part of a continuous water level monitoring.

5.2.2 System Options

The elements of a monitoring system described in Section 5.2.1 are considered a minimum for the monitoring system's expansion / improvement. It is assumed that the existing groundwater monitoring program (splitting samples with ENSR) will be continued.

In addition, one more OPCJ monitoring well could be constructed west of ED-16 and ED-20 (ED-20 is the new OPCJ currently under construction). Since Edina is increasingly relying on groundwater production from these western wells, it is considered beneficial for the City to monitor water quality coming to Edina from the west and toward ED-16 and ED-20.

5.2.3 Benefits/Impacts

Implementation of the expanded / improved monitoring program is considered essential to allow improved and more informed management and remediation decisions for the City of Edina in its efforts to protect and preserve groundwater resource.

5.2.4 Needs

Implementation of the expanded / improved monitoring program is considered essential for management of the Edina groundwater production and improved selection / control of remedial actions.

As in the case of existing monitoring activities (see discussion in subsection 5.1.4), it would be important to institute a continuous monitoring program specifying the necessary monitoring tasks, allocating responsibilities and identifying funding sources. Such program would specify, among other issues, the following:

- Program funding
- Coordination (between City of Edina, City of St. Louis Park, ENSR, MPCA)
- Leading coordinator
- Responsibilities (program execution, reporting, etc.)

5.2.5 Limitations/Constraints

It is possible that the data generated through this expanded monitoring program will allow a conclusion that no active remedial action is necessary. However, most likely the data will guide in selection of other, active remedial actions and configurations.

5.2.6 Timeline

It is recommended that the improved / expanded monitoring program be implemented within the next year.

5.2.7 Cost

The cost in addition to and beyond the operation of a current monitoring system will involve:

- Construction of two (or three) OPCJ monitoring wells
- Installation and operation of two additional dataloggers / transducers

- Groundwater sampling of the four OPCJ monitoring wells: ED-7 (only in case ENSR does not sample this well), ED Test Well, two or three new OPCJ monitoring wells
- Management of transducers, periodical downloading
- Data analysis, data management, modeling, reporting

5.3 Construction of Additional Municipal Water Supply Wells / Changing Configuration of Pumping From Municipal Wells / Creation and Maintenance of Hydraulic Barrier Between St. Louis Park and Edina

5.3.1 Description

Three related groups of remedial actions are considered here as options to help protect the City of Edina's groundwater resource against expansion of the VOC plume that is encroaching upon Edina from the direction of St. Louis Park:

- Construction of new municipal wells
- Changing configuration of pumping from the OPCJ municipal wells
- Creation and maintenance of hydraulic barrier between St. Louis Park (where the main body of the VOC plume resides) and Edina

These three groups of remedial options are related to each other for a variety of reasons, including the following:

- Construction of new municipal wells will not only augment groundwater production capacities of the City of Edina, but will also increase flexibility of shifting production between the wells. Pumping from the new wells will also change groundwater regime and gradients.
- Changing configuration of pumping from all Edina wells may include changing production rates from the new municipal wells.
- Creation and maintenance of a hydraulic barrier between St. Louis Park and Edina may be accomplished by a combination of pumping from Edina wells (ED-2, ED-13, ED-15) and from St. Louis Park / Minneapolis wells (SLP-6, Meadowbrook Well). Different combinations of pumping from these wells allow/necessitate (as discussed in the following sections) different production rates from the other Edina wells. These combinations also represent changing configurations of pumping from all the Edina wells.

For the reasons enumerated above, these three groups of remedial options cannot be discussed / analyzed separately.

<u>New Municipal Wells</u>

The City of Edina is currently constructing a new municipal water supply well, ED-20. This well located at Gleason Road, at the western edge of Bredesen Park (in the western part of Edina, short distance north of intersection of Gleason Road and Hwy 62), will be completed in the OPCJ aquifer. According to the City plans, production from this well will replace the production from ED-7 that was lost after that well was shut down in 2004, due to VOC contamination. Since this well is already under construction, completion of ED-20 is not considered part of the remedial action considered by this FFS.

The City of Edina is planning construction of one additional OPCJ municipal well, ED-21, to be located either at Garden Park or at Birchcrest Park (both parks are located in central part of Edina: Garden Park at Vernon Avenue, Birchcrest Park short distance north of Hwy 62 along railroad Soo Lane). According to the City plans, production from this well will replace the anticipated loss of production from ED-14 – that well will be shut down due to problems with radium contamination. Groundwater model predictive simulations indicate that ED-21 should be constructed at Birch Chest Park, rather than at Garden Park, to decrease the possibility of pulling VOC plume from the north toward the new well (STS, 2008c).

The perceived role of these two new wells is that additional production capacity will increase flexibility of the City of Edina to shift groundwater pumping between wells to address the following:

- Better protect the resource against the expansion of the VOC plume from the north
- Allow the City to respond to the potential loss of production from the radium impacted wells, ED-9, ED-14 and ED-17

These new wells also provide the City with a contingent source of water in the event of having to shut down additional wells as a result of increased impact of contaminants upon the wells. The City has identified eight additional wells within the Comprehensive Water Supply Plan. These wells are for the purpose of supplying water to a fully developed community. As the City grows, and the demand for water increases, the location and development of these eight wells must be conducted in recognition of the VOC plume and the influence that a new well(s) can have on the migration capabilities of the plume.

<u>Change Configuration of Pumping from Municipal Wells</u>

Ten groundwater pumping scenarios were modeled (predictive simulations) to explore the effect of a variety of pumping configurations upon the VOC plume. The model used for these predictive simulations was calibrated to groundwater conditions recorded to be present in the area near the boundary between St. Louis Park and Edina from Mid-September to Mid-November of 2007. During that time, groundwater was predominantly flowing from St. Louis Park toward Edina. These ten configurations are described in a separate Letter Report (STS, 2008c) and are summarized in the following Section 5.3.2.

5.3.2 System Options

Ten different municipal wells' pumping configurations were simulated by the updated Reilly Tar Site / Meadowbrook Groundwater Model (the Updated Model). The pumping wells represented in the model and the production rates assigned to these wells during different pumping configurations are listed in Table 5 of the Letter Report that is included in Appendix A (STS, 2008c) of this FFS Report. The predictive simulations utilized the MODPATH forward particles. These particles were planted in the area of the OPCJ aquifer where the VOC plume has been documented to be present. During predictive simulations the Model calculates these particles' pathlines. These model-calculated pathlines represent (in a crude way) the movement of the VOC contaminated groundwater. The results of these predictive simulations are illustrated by Figures 4, 10 and 13 taken from the modeling Letter Report (STS, 2008c) – these figures are also included in Appendix A of this FFS Report. As these figures show, almost all the groundwater VOC contaminants are intercepted by the area's municipal wells.

Pumping Configuration 1

This is the pumping configuration that was operated by the Cities of Edina, St. Louis Park and Hopkins during October and November of 2007. This configuration is designated here as a "baseline configuration" – all the consecutive configurations explored in the Model predictive simulations are compared to that "baseline configuration". As Figure 4 of Appendix A illustrates, under this "baseline configuration", all the VOC contaminants are intercepted by three northern Edina municipal wells: ED-2, ED-13 and ED-15.

Pumping Configuration 2

This configuration is identical to Configuration No. 1, except that two new wells, ED-20 and ED-21, are added to the system. Groundwater production from ED-20 is not significantly affecting groundwater contaminant pathways compared to "baseline configuration". However, ED-21 located at Garden Park intercepts some contaminants.

Pumping Configuration 3

This configuration is identical to Configuration No. 2, except that ED-21 is located further south, at Birch Chest Park. Under this configuration, ED-21 (marked as ED-20A) does not intercept contaminants, although it influences the flow field such that ED-4 intercepts some contaminants. Considering the conservative nature of this model predictions, the likelihood of ED-4 intercepting contaminants is limited (only two MODPATH particles intercepted) but cannot be excluded.

Pumping Configuration 4

This configuration is identical to Configuration No. 3, except that groundwater production is added to SLP-6. Pumping from SLP-6 results in decreasing (but not eliminating) contaminant migration to ED-2.

Pumping Configuration 5

This configuration is identical to Configuration No. 4, except that groundwater production is added to Meadowbrook Well, instead of to SLP-6. Pumping from Meadowbrook Well results in decreasing (but not eliminating) contaminant migration to ED-2, although to a lesser degree compared to configuration No. 4 – Meadowbrook Well is further away from ED-2 compared to SLP-6.

Pumping Configuration 6

This configuration is identical to Configuration No. 5, except that groundwater production is added to both Meadowbrook Well and SLP-6. Pumping from both of these wells results in a significant decreasing (but not eliminating) contaminant migration to ED-2 and, to a lesser degree, to ED-13.

Pumping Configuration 7

This configuration explores a possibility of shifting groundwater production from ED-2, ED-13 and ED-15, the wells that are currently intercepting VOC contaminants, to other Edina wells located further south. Under this configuration, production from these three wells is shifted to ED-10 (Mt. Simon aquifer well), ED-16 and ED-20. This pumping configuration results in pulling VOC plume toward southern Edina Wells: ED-4, ED-6, ED-20 and ED-21 (see Figure 10, Appendix A). This result suggests that Pumping Configuration No. 7 should be avoided.

Pumping Configuration 8

This configuration explores a possibility of shifting groundwater production from ED-2 and ED-15 to ED-10 and ED-16. Unlike under Configuration No. 7, current production from ED-13 is retained. Results of simulating this configuration are similar to the results calculated for simulation No. 7 - VOC plume is intercepted by the Edina southern wells (the result is similar to the one presented on Figure 10, Appendix A). Therefore, this pumping configuration should also be avoided.

Pumping Configuration 9

Pumping configuration under this scenario is the same as Configuration No. 8, except that both SLP-6 and Meadowbrook Well are pumped (like under scenario No. 6). Production from ED-2 and ED-15 can be shifted to more southern wells (one of them completed in Mt. Simon aquifer) without pulling the VOC plume further south under condition that SLP-6 and Meadowbrook Well are also pumped (at least during periods of time when groundwater flow direction shifts toward Edina). SLP-6 would even pull some VOC contamination back north from the area of northern Edina (thus remediating the Edina portion of VOC contaminated OPCJ aquifer).

Pumping Configuration 10

Pumping configuration under this scenario is the same as Configuration No. 8, except that ED-13 is turned-off and its production is added to production from southern wells. The purpose of simulating this configuration was to see if the effect of pumping from SLP-6 and Meadowbrook Well is enough to allow turning off (and shifting production to southern wells) not only ED-1 and ED-15, but also ED-13. As Figure 13, Appendix A illustrates, this is not the case. None of the explored and described above configurations (2 through 9) allows turning off ED-13.

Hydraulic Barrier between St. Louis Park and Edina

A hydraulic barrier preventing VOC plume movement toward Edina can be created either by pumping ED-2, ED-13 and ED-15 (current configuration) or by pumping from SLP-6, Meadowbrook Well and ED-13. This conclusion is based on the results of the Updated Model's predictive simulations. Pumping from these wells is recommended during periods of time when groundwater is moving from St. Louis Park to Edina.

5.3.3 Benefits/Impacts

Selecting a particular pumping configuration is critically important to the movement of the VOC plume, as the Updated Model predictive simulations document. Selecting a pumping configuration, along with other remedial actions, is necessary for maintaining groundwater production and for protection of the City's water resources.

5.3.4 Needs

Implementation of the appropriate pumping scenario needs to be augmented by other remedial actions (see discussion in the following section) and the effects of these actions need to be closely monitored (groundwater levels and quality monitoring).

5.3.5 Limitations/Constraints

It appears that none of the explored pumping configurations adequately address the issue of increasing VOC concentrations observed in ED-2. Some of the configurations clearly would increase a risk of pulling VOC plume further south and impacting more of the Edina wells (as illustrated by Figures 10 and 13, Appendix A). If the vinyl chloride concentrations in ED-2 were to plateau below the Federal drinking water standard (MCL) of 2.0 ug/L, then the pumping configuration represented by any of the predictive simulations No. 3, 4, 5, 6 and 9 would be adequate to maintain the Edina water resource and protect it against the expansion of the VOC plume from the north.

Otherwise, there is a need to address the possibility that water produced from ED-2 (and later possibly also from ED-13) will be unfit for drinking without treatment. It is important to note that both ED-2 and ED-13 need to be pumped to prevent the VOC plume from expanding further toward the south. It is also possible that during periods of time when groundwater flows toward Edina, pumping from ED-15 (in addition to pumping from ED-2, ED-13 or SLP-6/Meadowbrook Well) would decrease a chance of ED-21 pulling in VOC contaminants from the north.

Predictive simulation No. 9 represents a scenario under which ED-2 could be shut down. However under this scenario, while ED-2 is down, SLP-6 and Meadowbrook Well need to pump to control the southward expansion of the VOC plume. Water pumped from these wells could be either treated for public water supply use or it could be discharged to Minnehaha Creek, as VOC contamination levels are below Minnesota Surface Water Standards. However, the feasibility of pumping from SLP-6 and Meadowbrook Well would require a closer evaluation.

5.3.6 Timeline

The safest pumping configurations are represented by the predictive model simulations No. 3, 4, 5, 6 and 9. Among these, scenarios No. 4, 5, 6 and 9 include pumping from SLP-6 and/or Meadowbrook Well. Pumping from these wells would be associated with costs beyond the current operating and maintenance costs of the Edina water supply system. Pumping from these wells could be limited to periods of times where groundwater flows from St. Louis Park toward Edina. More economic operation of these wells would require linking them to some sort of automated groundwater level monitoring system.

5.3.7 Cost

Table 2 presents the costs for each alternative. The following lists the main categories of costs.

<u>Construction and Installation of ED-21</u>

Well construction, pump installation, construction of well building and connection of ED-21 to the distribution system are included in the project costs. Cost of well operation is not included since pumping is a requirement of water distribution and not a corrective action.

<u>Changing Configuration of Pumping – Edina Wells</u>

No costs are anticipated in addition to the current costs of the Edina water supply operation and maintenance.

<u>Changing Configuration of Pumping – Edina Wells plus SLP-6 and/or Meadowbrook Well</u>

Pumping SLP-6 and/or Meadowbrook Well are corrective actions not related to water use or water distribution. Therefore the cost of pumping is included. We assume that SLP-6 is functioning and does not require significant upgrade. We also assume that the Meadowbrook requires installation of a pump and distribution connection before the well could be utilized. No treatment costs are included. We assume that water from this well can be discharged to Minnehaha Creek at no cost. If treatment of groundwater by St. Louis Park for distribution is required, additional incremental costs may exist which are not included.

5.4 Construction and Operation of Water Treatment Plant

5.4.1 Description

The remedial option described in this section involves the treatment of Edina's source water by means of a water treatment facility. Water treatment options for consideration include the construction of either a new water treatment facility or upgrading an existing facility with the necessary treatment measures to remove vinyl chloride. Neither option is more effective than the other for the City of Edina, but both must be designed appropriately to remove vinyl chloride from the source water while maintaining a level of service to the users of the system. The option of a new treatment facility or upgrading an exiting facility is dependent on a number of factors. The most important factors are the cost and the time to have the treatment systems online. The timing for remediation (water treatment) is based on the increasing trend in vinyl chloride concentrations in the source water for the two highest producing wells for the City (ED-13 And ED-2). This section focuses on a treatment technique to reduce and/or remove vinyl chloride, and the recommendations for implementing water treatment as a corrective action.

The ability for the City of Edina's water system operators to remove vinyl chloride from the source water requires the design and development of an advanced treatment technique that is integral with the existing water system and water system operations. The treatment techniques that are most common for the removal of vinyl chlorides and other VOCs include air stripping, activated carbon, chemical oxidation, and reverse osmosis or membrane treatment. Air stripping is the preferred and most effective technique for the removal of vinyl chloride. Air stripping has a 95% or better removal efficiency rating when utilized in vinyl chloride treatment. The other alternatives, although effective to certain levels, do not provide the required level of removal and/or reduction of vinyl chloride concentration from Edina's source water.

Concerns have also been expressed with regards to Polynuclear-Aromatic hydrocarbons (PAHs) and the potential for these contaminants to have an affect on Edina's wells. The groundwater data has indicated the presence of total and carcinogenic PAHs in some Edina wells. Although the amount of up-gradient groundwater appropriated by Edina's wells is minimal, and changes throughout the year, the threat of PAH contamination is a realistic concern, and one that should not be ignored in current and future studies. Treatment of PAHs is customarily addressed through the implementation of activated carbon. St. Louis Park has developed and implemented large scale activated carbon systems to treat PAHs in ground water, and has been successful with these systems.

The remedial option of this section focuses on water treatment by air stripping with recommendations for integration of treatment systems into the existing treatment facilities No. 4 and No. 1. Although the focus of this study is vinyl chloride, additional language has been added to this section of the report that evaluates activated carbon as a treatment methodology for the City of Edina.

5.4.2 System Options

The implementation of a particular water treatment technique depends on a number of factors, the most important among them are the type of contaminant in the water, and the daily demand (flow rate) placed on the water system. For the City of Edina, the contaminant of concern is vinyl chloride. PAHs are being reviewed as a secondary source water contaminant based on observed concentrations of these contaminants within the groundwater resources up-gradient of the Edina well field.

A full understanding of the source water chemistry is required when developing a particular treatment strategy. The water treatment techniques discussed within this report are those that were determined to be the most practical for the City of Edina and best suited for treatment of the fore-mentioned contaminants. The technique that will be covered in this report is Aeration (Air Stripping). Activated carbon will be discussed in similar detail because of its historical use, when treating for PAHs in St. Louis Park.

Aeration – Air Stripping

Aeration is a mechanical treatment methodology applied to source waters where a large volume of air is passed through the water to remove VOCs and other constituents out of solution. Aeration is used to alter the concentrations of dissolved gases, to strip volatile organics, and to reduce tastes and odors. Vinyl chloride and other VOCs are easily removed from the water due to there volatile properties. As air is introduced into the water, the VOCs quickly volatize (turn to vapor), and are removed from solution into the atmosphere. In most cases, the pressure in the system is reduced to atmospheric level which allow a much faster rate of exchange from the liquid to gas phase for the dissolved gases.

Aeration is also an effective means to remove dissolved iron and manganese when the source waters are rich in these metals. In the case for the City of Edina, the City currently employs a filtration system to remove iron and manganese prior to the distribution of the water. If the decision is made to move forward with aeration as the treatment technique, it is highly recommended that the City continues to employ the use of filtration device to remove as much iron and manganese as possible prior to aeration. The life and efficiency of the air stripper is dependent on effective removal of these metals. Filtration and other pre-treatment methods will not be discussed within this study, but shall be considered with the design and development of a treatment facility or system upgrades if water treatment is the choice of corrective action.

A separate issue that requires attention with this treatment technique is the volatizing of VOCs into the atmosphere. Attention must be given to local air quality; specifically in the cases of confined spaces. The confined space must be equipped with air purifying system or air ventilation system equipment designed to fluctuate the air in-and-out of the confined space. Or, a secondary control mechanism could be integrated into the air stripping tower to adsorb the gases released from the volatizing process. In case the stripping process results in VOC concentrations above the air quality criteria, the VOC contaminated air may be treated with activated carbon filters, prior to release into the atmosphere. Activated carbon filters have been found to be effective in removing VOCs from the contaminated air. The air quality issue will be addressed later in this report.

Although aeration is an effective technique for the removal of vinyl chloride and other VOCs, it is not a technique that is effective for the removal of PAHs and organic matter. As in most treatment facilities, several treatment methods must be employed to treat a source water. In the case for the City of Edina, current treatment methods of filtration must continue to be provided for the aeration to be effective. If PAHs contamination must be addressed, then an additional treatment technique or single treatment technique proven to be effective in removing or reducing the concentrations of these contaminants must be used. The following section of this report will evaluate Activated Carbon as a treatment technique for the City of Edina's water distribution system.

Activated Carbon – Vinyl Chloride

Activate carbon is used in water treatment applications in the forms of both powder and granules. Each method is specific to the application and/or degree of water quality a system operator is seeking. GAC is a natural material derived from bituminous coal, lignite, wood, and coconut shells. These products are processed to produce a highly porous medium capable of adsorbing contaminants and other constituents dissolved and suspended in the water. The efficiency of the adsorption process is dependent upon the GAC particle size, pore size, surface area, density, and the solubility and concentration of the identified contaminants. The removal of carbon based contaminants is highly effective with GAC due to the attractive nature of the carbon molecules with the activated carbon surface. For the purpose of this study, and the suitability to the City of Edina's needs, the focus shall be on Granular Activate Carbon (GAC).

GAC removes contaminants through an adsorption process in which dissolved and suspended contaminants adhere to the surface, and are held (adsorbed) within the pores and on surfaces the carbon particles. The method of GAC water treatment has been proven most effective when attempting to remove carbon-based contaminants within the source water. As stated, removal rates depend on the concentrations of the contaminants, and the flow rate of the water. The relationship is simple, the higher the contaminant concentration and flow rate of water, the more surface area (GAC material) will be needed to treat the water. GAC products themselves are developed (processed) and used on a case-by-case basis dependent on the contaminants in the source water. In the case of the City of Edina, with the concerns of elevated vinyl chloride concentrations, GAC can be applied and be slightly beneficial for the quality of Edina's water, but it is not recommended as the only treatment technique when trying to reduce the concentrations, or completely remove vinyl chloride. The small molecular composition of the vinyl chloride does not allow for adsorption to effectively occur. Vinyl chloride intermittently adheres to the GAC surface and within the pores until it becomes "flushed-out" of the pores and/or gets "brushed off" the particle surfaces by other larger contaminants in the source water. This event creates "spikes" in the water system where larger concentrations of vinyl chloride are suddenly released into the potable stream and are unnoticed by system operators. GAC products can be produced to a "micro-pore" type product, but the frequent replacement and maintenance costs increases by multiple factors, for what will ultimately be very little improvement in the removal efficiency of vinyl chloride. It should also be noted that when treating vinyl chloride with GAC, the Environmental Protection Agency (EPA) has stipulated that the GAC must be supplemented with an aeration system to effectively remove or reduce the concentrations of vinyl chloride. GAC is highly effective as a stand alone treatment technique with other VOCs, organics, and some metals, but when treating for vinyl chlorides, it is recommended that additional measures be implemented.

Vapor emissions of vinyl chloride, as discussed with treatment of vinyl chloride by aeration, could be addressed through the implementation of activated carbon. Activated carbon has proven to be an effective measure to address the air emission issue associated with treatment of VOCs by aeration. Dependent upon the corrective action proposed to address the City of Edina's source water issue, the vapor issue will also be considered in the overall corrective action design.

Contrary to GAC having an effective nature to remove vinyl chloride from the air (vapor), its ability to remove vinyl chloride in solution, is very difficult and in most times is negligent. GAC treatment of vinyl chloride is typically used as an emergency response measure such as after or during a chemical spill. The City of St. Louis Park conducted a study of effectiveness of activated carbon in removing VOCs form contaminated groundwater. It was found that the effectiveness is very low (Scott Anderson, Superintendent of Utilities – personal communication).

Activated Carbon – PAHs

GAC has proven to be effective in removing PAHs from the source water. As stated previously, these contaminants have been identified in the source waters up-gradient from the Edina well field, and for precautionary reasons, it is necessary to evaluate treatment techniques for additional considerations when making recommendations for corrective action.

Carbon based contaminants have an attractive nature to the carbon-based surfaces of the GAC materials. GAC particles and their adsorption capabilities (removal efficiency) are again dependent upon the identified contaminants and the flow of water. Based on the "Pump and Treat" methodology that we have been discussing, activated carbon has been used best in this method to reduce/remove the following contaminants:

- Aromatic Solvents
- Chlorinated Aromatics (PCBs, Chlorobenzenes, Chloroaphthalene)
- Phenol and Chlorophenols
- Polynuclear Aromatics (acenaphthene, benzopyrenes)

The City of St. Louis Park has designed and developed a series of activated carbon treatment systems to remove PAHs identified in their local groundwater resources. Along with the required monthly/annual maintenance to operate these systems, the City of St. Louis Park has been able to achieve removal efficiencies that meet, and exceeded current drinking water standards.

Removal efficiencies have been found to be 90% or better when removing some PAHs based on the appropriate activated carbon materials selected. GAC treatment measures do require a level of maintenance and service by the system operators to sustain the high removal efficiency rates. Backwashing of the particles will be necessary as the pore spaces and surfaces of the GAC particles reach adsorption capacity, disinfection may also be necessary considering microbial growth within the GAC system, and ultimately replacement of the carbon product will need to occur as the particles break down. The level of maintenance can only be defined subsequent to the use and operation of the system, and monitoring the effects. GAC is a relatively inexpensive and easy product to obtain, making this method even more attractive for system owners.

Based on the information collected for PAHs concentrations, a significant flow (volume) of water would have to occur through the activated carbon product prior to reaching the adsorption capacity of the carbon particles. At the present time, these concentrations do not appear to be of such magnitude that large activated carbon systems and significant maintenance would be required. As with most treatment systems, it will be necessary to perform batch testing of the source water to determine the appropriate carbon treatment method prior to a water treatment system design.

5.4.3 Benefits/Impacts

The benefit of a treatment facility or upgrading an existing facility is the ability to provide a clean source of water for an extended period of time, regardless of groundwater impacts. Upgrading treatment plants No. 2 and No. 4 with air stripping provide the means to remove the vinyl chloride from source wells ED-2 and ED-13. These wells have shown an increasing trend in vinyl chloride and if this trend continues these wells may exceed the drinking water standard in the future. The ability to treat the source water from ED-2 and ED-13 by aeration at the treatment plants will allow for the continued use of ED-2 and ED-13 at the current production (pumping) rate. The additional benefit of maintaining the production rate of the wells is the creation of the groundwater “Hydraulic Barrier” which serves as a safeguard to Edina’s southern well field. The barrier restricts the ability for the VOC plume to migrate by hydraulic grade or migrate by the effects of pumping of the southern wells.

Impacts as a result of implementing a system upgrade are minimal. The system would require a temporary shutdown to accomplish the tasks of installing the new treatment devices and integrating the systems. A temporary water pumping configuration will be required to meet system demands for the time the integration is occurring. Other impacts are those to the existing treatment facility itself for expansion reasons or replacement of equipment to allow for the integration to occur.

5.4.4 System Needs

The parameters for the design and development of a treatment facility or facility upgrade are the raw water chemistry data, current and projected volumes of flow, land available for construction of the plant, or space available within the existing plant, and treatment methods of choice. A complete and accurate understanding of the contaminants and other constituents in the source water is also critical. Treatment methodologies are directly related to the concentration levels of the contaminants and other source water constituents.

5.4.5 Limitations and Constraints

The limitations and constraints concerning the implementing of a water treatment facility are similar to the needs for the design and development of the water treatment plant. The largest concern by most system owners is the acquisition of land to construct the facility and the ability to upgrade an existing system. The size of the facility is a design function of the flow (volume) of water projected to pass through the facility, and undergo treatment. The location is also a concern due to the growth and development of adjacent properties, and the inability to operate a treatment plant from a remote location, away from urban activity where the demand of water is high. It is preferred by most owners that treatment facilities be integrated into the current water distribution system without having to extend the network to other areas of the City. The ability to construct the plant and tie into the existing system without much impact is preferred. Construction of a treatment plant at ED-7 is not recommended if such plant were to treat water produced from that well. Pumping ED-7 would pull the St. Louis Park centered VOC plume further south into Edina.

5.4.6 Timeline

The time associated with the planning, and design and development of a new treatment facility could be 1 to 3 years or more. The nature of Edina's source water issues may not allow for this much time to lapse should the levels of vinyl chloride keep increasing. Development of a new treatment system (aeration) or integration of these controls and equipment with existing facilities is time consuming, but much less time consuming than that of a new facility. The time to design and integrate an aeration system is approximately 6 months to a year depending on the improvements required to make the integration work. An evaluation of treatment facilities No. 4 and No. 1 should be conducted prior to design work.

5.4.7 Cost

Costs for the design and development of a new treatment facility and upgrading one or more existing facilities are provided in Table 2.

A cost analysis for an activated carbon system has been provided in Table 2.A. These costs are for comparative purposes only.

5.5 Purchasing Water From Neighboring Cities, Construction of Interconnection Mains

5.5.1 Description

A component of this Focused Feasibility Study (FFS) is to evaluate the feasibility of implementing a "Water System Inter-Connection" with an adjacent municipality to address both the potential impact to the existing system and current water supply needs for the City of Edina. Edina is the neighbor to seven municipalities; each with their own water distribution and source water supplies systems. STS met with several City staff personnel representing the adjacent municipalities who have the responsibility of operating and maintaining the water distribution system for their respective communities. A plan review and discussion was conducted with these individuals concerning the City's ability, and general thoughts of implementing a plan to construct a water system interconnection. This chapter of the FFS discusses the results of these meetings, and outlines the variables to be considered, and further evaluated, for implementing a water system interconnection.

5.5.2 System Options

System options for implementing a water system interconnection plan or project includes interconnecting with one or multiple municipal water suppliers within reach, or reasonably close to the City of Edina's current water distribution system. Municipal water suppliers beyond those previously identified are not considered a feasible alternative for an interconnection. Although the possibility exists, the costs associated with new infrastructure, land and easement acquisitions, and multiple use (Joint Powers) agreements render the concept not feasible and ultimately not relevant for this FFS. The focus of this study is applied to the immediate (adjacent) municipalities to the City of Edina. These municipalities are outlined below.

Municipalities

- St. Louis Park
- Richfield
- Bloomington
- Hopkins
- Minnetonka
- Eden Prairie
- Minneapolis

The water distribution system for each municipality is designed and operated specifically for the operators and users of the system. The source water supply, treatment methods, and infrastructure characteristics are unique to each system, and must be properly understood and evaluated to allow for an interconnection to be implemented. As a result, the task of designing, operating and maintaining a water system interconnection is a challenge to the engineers and operators of the system. The variables that must be considered for the design are outlined below:

Design Considerations

- Infrastructure
- Water Chemistry
- Water Pressure
- Supply and Demand Capabilities

Infrastructure

Infrastructure (streets and utilities) was evaluated for the City of Edina and each adjacent municipality with respect to the location and size of existing watermain systems. The ability to implement an interconnection ultimately requires the development of new infrastructure (watermain), upgrades to existing data systems, expansion of telemetry, and new controls to operate, record and monitor system activity. An evaluation was performed with respect to the capability of interconnecting existing systems and developing/constructing a new system(s) to allow for the interconnection to occur at the present time or in the near future.

Water Chemistry

Perhaps the most important design consideration when evaluating the feasibility of interconnecting two or more water systems is water chemistry, and treatment methodologies for each system. A water distribution system is designed and operated specifically for the operators and users of the system. Water chemistry and treatment methods are unique to the system itself. Very costly infrastructure systems are developed for reasons identified by the operators and users, and paid for through the daily (monthly) use of the water. Water chemistry and treatment information has been collected from the City of Edina and adjacent municipalities. Similar to other design considerations, this information was used in the evaluation process and feasibility of interconnecting water distribution systems.

Water Pressure

Similar to the infrastructure needs identified within the infrastructure evaluation of this report, water pressure must be considered when designing an interconnection. Water pressure (pressure zone) is a designed feature and functional component of all water distribution systems. The water pressure of a municipal system is designed specific to the system and desire of the users. The difference in pressure from one system to the next can result in a flux of water and overcome the adjacent system. The interconnection must have the appropriate pressure reduction capabilities or "boost" in water pressure as water is drawn in either system by its respective customers. Water pressure information was collected and used in the evaluation of this study.

Supply and Demand Capabilities

The supply and demand capabilities for the City of Edina and adjacent municipalities was evaluated with respect to the following:

- Growth Potential – Land Development
- Growth Rate – (Met. Council)
- Current Supply and Demand
- Comprehensive Plans

Although these parameters may arguable be an indirect method of evaluating the supply and demand capabilities for each municipality, each item does correspond to an effect on water consumption for the municipality, and ultimately the supply and demand issue. A review of each of the City's Comprehensive Plans was also conducted for reasons similar to identifying land development or land use plans that may have an effect on the supply and demand of the City in the near future.

Even though these design considerations are inclusive to other system variables and specific issues, they have been utilized as the basis for the evaluation and feasibility of a water system interconnection for the City of Edina. The findings and recommendations of this evaluation are summarized in the attached Table (Table 1). Conclusions and recommendations for action are discussed within Chapter 8 of this report.

5.5.3 Benefits and Impacts

The benefit of an interconnection with an adjacent municipality is the ability to utilize water resources from the adjacent community when the need arises. The interconnection of water distribution systems provides capabilities for both systems to function and provide water to the consumers during emergency situations. The operators can be assured of a water supply to the consumers from their respective supply systems or the adjacent municipality. The concept also provides more versatility when considering system maintenance requirements and the need to temporarily shut down wells while maintaining the supply of water.

The impact of implementing an interconnection with an adjacent municipality is the cost of new infrastructure, control systems, and existing system upgrades to provide a water supply that is of the same (not similar) nature in pressure and chemistry of the connecting system. The ability for the City of Edina, or adjacent municipality, to develop new systems equal that of its counterpart are very costly and show very little benefit from a user standpoint. New infrastructure typically results in the need for additional staff persons to monitor and maintain the system and/or creating a need for a specialized people and equipment required to operate the system. Again, additional cost to the City/cities for implementing the interconnect.

Customary to owning and operating a water distribution system is the development of a Contingency Action (CA) plan that identifies alternate means and methods of supplying water in emergency and/or system failure type situations. Alternative water supplies typical to the development of these plans are an interconnection with an adjacent municipality. In the event that the City of Edina elects other means to address water supply and demand, a supplement may be added to the current CA plan, and budget, to further evaluate the possibility.

5.5.4 Needs

The needs for the implementation of an interconnection have been previously stated but again include new or a replacement of existing infrastructure, and engineering to design two compatible systems. SCADA systems must be upgraded with the necessary telemetry and capabilities to monitor system activity. Additional public works personnel should also be considered to support the work effort of the City's public works department.

5.5.5 Limitations/Constraints

Limitations and constraints include the availability of adjacent infrastructure systems funding to construct new infrastructure and create the connection. Water pressure and chemistry are major concerns for the operators and users of the system, and will pose an issue with ability to develop and maintain a contiguous system that balances the chemistry and pressure of the water for both systems. An additional concern is the political side of connecting to separate municipal systems. Agreements between the municipalities must be in-place to define costs and responsibilities of operations and maintenance.

Connecting SLP6 to the Edina water system, to be pumped to maintain hydraulic barrier would not be readily implementable. The water produced from that well would be contaminated and would need to be treated prior to any use as a municipal water. Water supply lines connecting the well to Edina would need to be constructed.

5.5.6 Timeline

The timeline for planning, designing and implementing an interconnection of systems can range from two to five years. A study will be required and could take up to a year to develop. The construction phase of the project including street and utility work, SCADA and telemetry system upgrades, water treatment plant upgrades, and integrating of adjacent systems could take an additional two to three years, depending on the timeline of infrastructure improvement projects for interconnecting municipalities.

5.5.7 Cost

The cost associated with the interconnection and developing and constructing compatible systems with one of the aforementioned municipalities is provided in Table 2 – Estimated Costs for Remedial Alternatives. The costs for new infrastructure systems are relatively the same when considering a connection to any of the adjacent municipalities. The costs associated with the design and development of construction plans, construction of the infrastructure, and equipment purchases have been summed together and included as a capital expense within Table 2. Maintenance of the new infrastructure is projected out to 10 years of operations. These costs are what the City of Edina could expect for the development and operation of the interconnection.

6.0 Other Considerations

6.1 Fee Schedule/Rate Adjustment

The City of Edina may consider preparing a motion to the City Council or the Utility Commission for a revision to the current fee schedule or water use rates. The motion for a revision is to justify the capital costs associated with planning and implementing the corrective action plan to mitigate the source water. A fee rate study could be conducted by a third party to determine the justifiable adjustments to the rate, and who are the users that may or may not benefit from the adjustment.

6.2 Water Conservation – Ordinance Development

The City of Edina currently has a water conservation ordinance applicable to all users of the water system. Section 1115 **-** Water Emergencies and Irrigation Bans imposes limits of water use for irrigation purposes. The City may consider developing an amendment to the ordinance for additional restrictions or exemptions of the users to limit the use of water during the growing season in an effort to conserve water and avoid a shortage occurrence.

6.3 Use Agreements With Golf Course – Irrigation

Due to the aggressive need to irrigate the local golf courses, the City may consider entering into a use agreement with the golf course owners for use of the water during the times of the needs; particularly during the growing season. The use of water could contribute to the remedial actions of pumping to manage plume migration, and sustaining a hydraulic barrier in the groundwater hydraulics as discussed previously.

7.0 Comparative Analysis of Remedial Alternatives

7.1 Overall Protection of Human Health and the Environment – Threshold Criterion

Human health is not anticipated to be adversely impacted by exposure to the City of Edina produced contaminated groundwater, regardless of the remedial option adopted. However, water shortages caused by potential shutdowns of the Edina municipal wells might result in inconveniences and economical losses (see discussion in Section 4.1).

7.2 Compliance with ARARs

All the remedial options evaluated in this FFS will have to comply with "Applicable or Relevant and Appropriate Requirements" (ARARs).

The focus of all the considered remedial options is to assure supply of safe drinking water for the City of Edina. Municipal water is regulated under the Safe Drinking Water Act. Consequently, all the options will have to comply with the chemical-specific ARARs – Federal and State of Minnesota drinking water standards - MCLs (Federal Maximum Contaminant Levels) and HRLs (Minnesota Department of Health, Health Risk Levels), respectively. Groundwater samples collected from the wells and/or water distribution systems will be subject to low-level VOC laboratory analysis using the USEPA method 8260). "No active remediation" options may result in non-compliance with MCLs/HRLs. "Construction of Additional Municipal Wells / Changing Configuration of Pumping / Creation of Hydraulic Barrier" remedial options may or may not result in compliance with MCLs/HRLs, depending on how these options will affect the VOC plume. "Construction and Operation of Water Treatment Plant(s)" and "Purchasing Water from Neighboring Cities, Construction of Interconnected Mains" remedial options will comply with this ARAR. One exception may be purchasing St. Louis Park water pumped from SLP-6.

"Pumping Configuration No. 10" remedial option may require NPDES permit and compliance with Class 2A Minnesota Surface Water Standards, if the groundwater pumped from SLP-6 and/or Meadowbrook Golf Course Well were to be discharged into Minnehaha Creek. It is anticipated that concentrations of the groundwater contaminants would not exceed the Minnesota Standards and, therefore, comply with these chemical-specific ARARs.

Operation of air strippers at Water Treatment Plant(s) may result in air contamination. These operations will comply with the Minnesota Department of Health, Health Risk Values (HRVs). HRVs will constitute chemical-specific ARARs.

Construction of additional water supply wells, well sampling, connection of the Edina water supply system to neighboring systems will be subject to review and approval to construct the water system by the Minnesota Department of Health (MDH) and other relevant regulations. The MDH regulations constitute action-specific ARARs.

Construction and operation of Water Treatment Plant(s) will be subject to all the relevant State and County regulations, codes, permits and approvals constituting action-specific ARARs.

There are no location-specific ARARs anticipated, unless construction of Water Treatment Plant(s) or water mains will affect wetland areas or will take place within flood zones.

7.3 Long-term Effectiveness and Performance

The City of Edina's water supply system is primarily dependent on the groundwater resource of the OPCJ aquifer system. This aquifer in the northern portion of Edina and over much of the area of St. Louis Park is contaminated with VOCs. Considering the large area of the VOC plume (three miles in diameter), its dispersion and degradation will take decades. Therefore, it is likely that some of the City of Edina municipal wells (ED-2, ED-13 and ED-15) will produce contaminated groundwater for decades to come. All of the remedial options presented in this FFS are designed to control the VOC plume and to allow an adequate groundwater production. Therefore, long-term effectiveness of most of the discussed remedial options that depend on controlling VOC plume and pumping is anticipated to be limited. The most effective options, like water treatment plant or purchasing water, are also the most expensive. It appears that the complete solution will require implementation of several options at the same time, each option characterized by a different level of effectiveness and performance (like current pumping scenario and construction and operation of treatment plant(s)).

7.4 Implementability

Those remedial options that involve just reconfiguration of pumping are the easiest to implement. The options involving pumping from SLP-6 and/or Meadowbrook Well are more difficult to implement. Arrangements would need to be made with the City of St. Louis Park how to finance pumping from SLP-6 and what to do with the pumped contaminated water. Arrangements would need to be made with the City of Minneapolis how to finance upgrading the Meadowbrook Well to allow high capacity groundwater pumping from that well, how to finance the well operation and what to do with the pumped contaminated water.

Construction of water treatment plant(s) appears to be a needed, although relatively expensive, element of any remedial solution. According to the preliminary analysis included in this FFS, purchasing water from neighboring cities would be a difficult and expensive remedial option. Moreover, implementing this option would not eliminate the need to maintain hydraulic barrier by pumping from ED-2, ED-13, ED-15 (or ED-13, SLP-6 and Meadowbrook Well) to prevent the VOC plume from migrating toward the other Edina wells further south.

7.5 Short-term Risks

None of the presented remedial options is considered to have any significant potential for causing short-term risks. The only remedial options that were characterized as associated with a moderate to high potential for short-term risk are those pumping configuration options that would likely result in moving the VOC plume south and toward other Edina municipal wells. It is possible that new Edina wells might get contaminated in a relatively short period of time, between the prescribed sampling events.

7.6 Estimated Costs and Schedule

The remedial options involving reconfiguration of pumping are relatively inexpensive. The only exception is pumping from SLP-6 and/or from Meadowbrook Well. Pumping these wells would involve substantial cost of operating the wells and handling the pumped water and would require agreements on cost with the cities of St. Louis Park and Minneapolis. In addition, upgrading the Meadowbrook Well would involve considerable up-front cost.

Construction of water treatment plant(s) represents a relatively expensive although highly recommended option (see discussion in Section 8.0).

Purchasing water from neighboring cities and construction of interconnection mains (needed for that remedial option) represents the most expensive and still only a partial solution to the problem of sustained clean water supply facing the City of Edina.

7.7 Reduction of Toxicity, Mobility or Volume (TMV) Through Treatment

Those remedial actions that involve construction of additional municipal wells / changing configuration of pumping / creation of hydraulic barrier will not reduce toxicity or volume of contaminated groundwater. However they will reduce its mobility.

Construction and operation of water treatment plant(s) will reduce toxicity of the contaminated water before it enters public distribution system. As far as water distribution is concerned (as opposed to the contaminated aquifer), processing water at the treatment plant will also reduce mobility or volume of contaminated water.

Purchasing water from neighboring cities, construction of interconnected mains will not reduce toxicity, mobility or volume of contaminated groundwater.

7.8 State Acceptance

Remedial options with the potential to solve the problem of a clean water supply, without exacerbating environmental conditions or additional exposing of human population to contaminants, should be acceptable to the State. The only options among the considered that are judged to be unacceptable to the State are those pumping configurations that would result in expansion of the OPCJ VOC plume toward the south.

7.9 Community Acceptance

Remedial options with the potential to solve the problem of a clean water supply, without exposing of human population to contaminants, should be acceptable to the community. Local communities may object to remedial options that would increase the risk of southward VOC plume expansion. They may also object to selection of excessively expensive options, like construction of interconnection mains. Also, the communities outside of Edina may object to pumping from SLP-6 and/or Meadowbrook Well.

The summary of the comparative analysis and scoring of remedial alternatives is presented in Table 3.

8.0 Conclusions

A. ED-2, ED-13 and ED-15 Contamination

Concentrations of chlorinated VOCs detected in ED-2, ED-13 and ED-15 show an increasing trend. Contamination of ED-2 and ED-13 is of greatest concern. Concentrations of vinyl chloride detected in these high-production municipal wells in May of 2008, 1.4 ug/L (ED-2) and 0.6 ug/L (ED-13), are approaching a federal drinking water standard, MCL (2 ug/L). Therefore, it is important for the City of Edina to have a contingency plan. If the measured concentrations of vinyl chloride exceed the MCL for 4 consecutive quarters, the wells may need to be treated or blended.

B. Maintain a Hydraulic Barrier Between St. Louis Park and Edina

Groundwater model predictive simulations indicate that ED-2, ED-13 and ED-15 intercept the VOC plume and prevent it from migrating further south. Further southerly VOC migration would likely occur if ED-2, ED-13 or ED-15 were shut down. This would cause contamination of a larger area of the OPCJ aquifer and would eventually impact other Edina municipal wells. The model predictive simulations point to the possibility that pumping SLP-6 and/or Meadowbrook Well would decrease VOC contaminant migration to ED-2 and would even allow shifting part or the entire ED-2 production to wells further south, without pulling the VOC plume further south. However, the issues associated with feasibility of discharge and/or treatment of contaminated water from SLP-6 and Meadowbrook Well are a concern. The conclusion is that a combination of pumping from ED-2, ED-13, ED-15, SLP-6 and Meadowbrook Well is needed to prevent VOC plume from migrating further south. Such pumping is needed during periods of time when groundwater is migrating toward Edina – periods of such movement can be identified based on continuous water level monitoring.

C. Establishment of a Structured Monitoring Program

Establishment of a systematic and long-term monitoring program is of essential importance. A Monitoring Plan should be developed to include, as a minimum, the following:

- List of monitoring wells subject to periodical water quality sampling
- Schedule of water quality sampling
- List of monitoring wells subject to continuous water level monitoring
- Responsibilities of parties involved in carrying out the monitoring activities
- Required analysis
- Required reporting
- Funding sources to operate the monitoring program

D. Upgrade the Monitoring System

Upgrading the monitoring system is recommended. Improved monitoring would allow better control, adjustments to and operation of the selected remedial option systems. Data collected by the enhanced monitoring program might allow a conclusion that the current pumping scenario (with ED-2, ED-13 and ED-15 intercepting the VOC plume and also the PAH plume) is an adequate and sufficient remedial option. However, it is more likely that vinyl chloride concentrations will exceed MCL levels.

The upgraded monitoring system should include additional OPCJ monitoring wells, subject to continuous water level monitoring and periodical water quality sampling. In particular, such an upgraded system should be utilized to monitor the hydraulic barrier between St. Louis Park and Edina.

E. Water Treatment Plants and/or Purchasing Water from the Neighboring Municipalities, while Maintaining Hydraulic Barrier

The following two options should be considered (in addition to operating the upgraded monitoring system and collecting the all important monitoring data) if vinyl chloride concentrations detected in ED-2 exceed the MCL level:

- Continue operating ED-2 and process the produced groundwater at a local/dedicated treatment plant (either upgrade the existing plant or construct a new plant).
- Shut down ED-2, start pumping from SLP-6 and Meadowbrook Well, and shift the ED-2 production to other wells, or supplement the lost production by purchasing water from neighboring cities.

Other options would need to be implemented in case VOC contaminants were detected at excessive concentrations in ED-13, ED-15 and also in other wells. Either the contaminated water would need to be treated or the production shifted to other wells, as long as the hydraulic barrier between the cities is maintained.

F. Summary

The overarching conclusion of this FFS is that, in addition to the current pumping configuration (including production from the two new wells – ED-20 and ED-21), the City of Edina should have a treatment plant ready to process VOC contaminated groundwater. Alternatively, shutting down ED-2 would necessitate pumping from SLP-6 / Meadowbrook Well to maintain hydraulic barrier between the cities. ED-13 cannot be shut down during periods of time when groundwater flows toward Edina – there is no other nearby well available to provide the needed “hydraulic barrier maintenance function” served in that area by ED-13.

Purchasing water from the neighboring municipalities represents only a partial solution, since pumping from the contaminated wells would still need to be continued to maintain the hydraulic barrier and to protect the other Edina wells.

Data collected from the upgraded monitoring system could be used for timing the operation of the established remedial system – i.e. continuous monitoring of water levels would allow identifying periods of time when it is permissible to shut down the contaminated wells (ED-2, ED-13 and ED-15) and the associated treatment plants. During periods of time when groundwater flows away from Edina (according to the data accumulated to date - most of the time), water production lost from such shutdowns could be shifted to other Edina wells, or lost production could be supplemented by purchasing water from the neighboring municipalities, without running a risk of pulling the VOC plume further south.

The summary of the recommended remedial action options is presented in Table 4.

9.0 General Qualifications

The evaluations and opinions presented in this report were developed from a consideration of the project area characteristics and interpretation of available data. STS' interpretation of available data is based on normally accepted reasonable engineering judgment. STS' opinions of probable total project costs were made based upon STS' knowledge, experience and qualifications and represent STS' judgment as an experienced and qualified professional engineer familiar with the construction industry but STS cannot and does not guarantee that project costs will not vary from opinions of probable cost provided by STS.

STS professional services were performed in accordance with generally accepted engineering practices. This warranty is in lieu of other warranties, either expressed or implied. STS assumes no responsibility for data or interpretations made by others. STS assumes responsibility for the accuracy of the report's contents subject to what is stated elsewhere in this section but recommends that the report be used only for the purpose intended by the client and STS when the report was prepared. The report may be unsuitable for other uses and reliance on its content by anyone other than the client is done at the sole risk of the user.

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Figures

Tables

Appendix A

[redacted]

ina, Minnesota
ter Distribution System Analysis

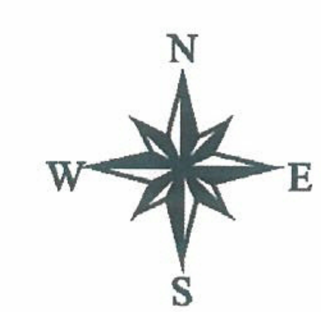
Legend

Existing Water Supply System

- Well without Treatment
- Water Treatment Plant #1
- Well Treated by WTP #1
- Water Treatment Plant #2
- Well Treated by WTP #2
- Water Treatment Plant #3
- Well Treated by WTP #3
- Water Treatment Plant #4
- Well Treated by WTP #4

Raw Watermain

8 Inch



Existing Water Supply System

NOTE: DIAGRAM BASED ON PLAN PROVIDED BY SHORT ELLIOT HENDRICKSON.

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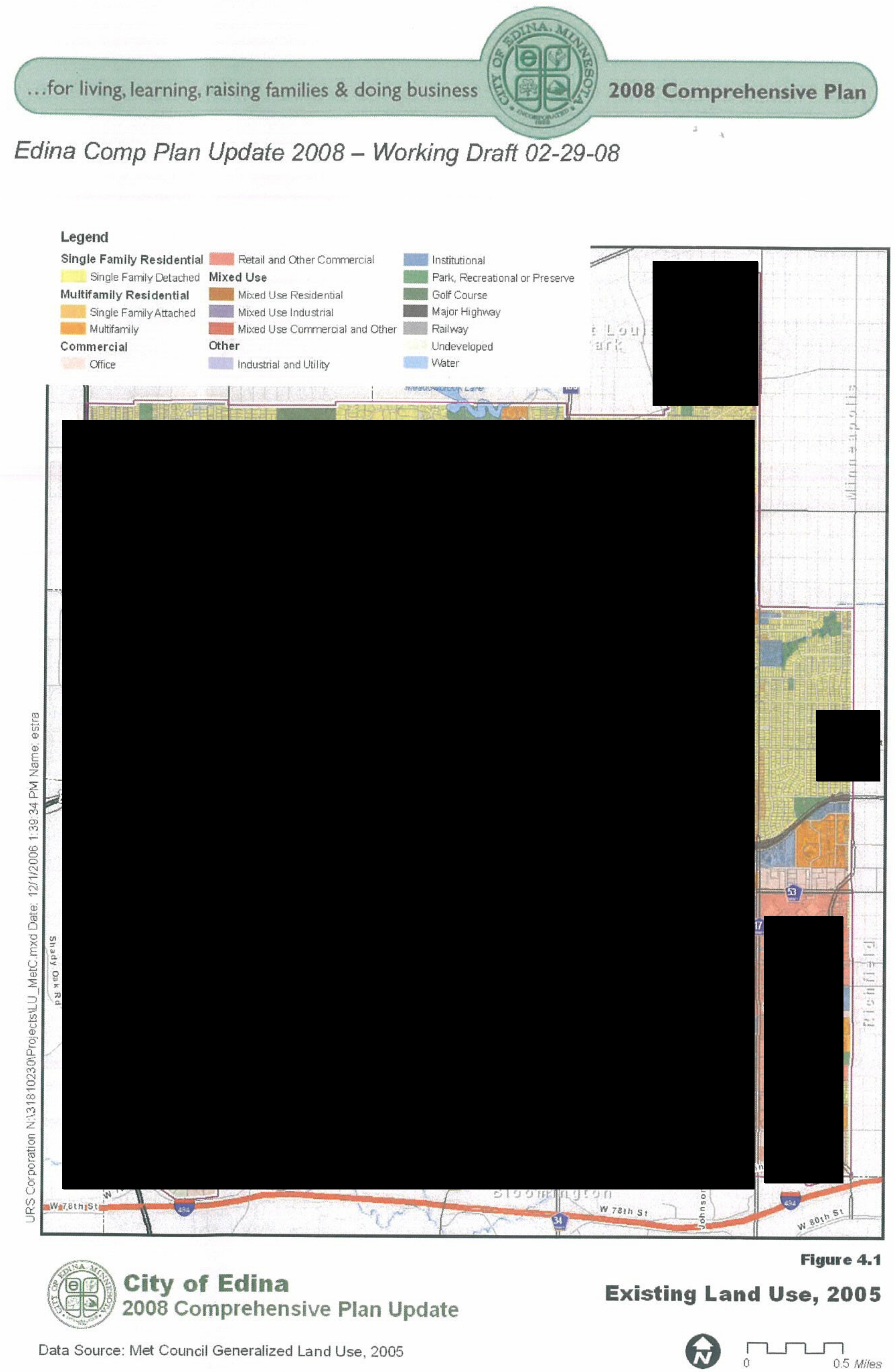
WELL & TREATMENT PLANT LOCATION

EDINA WELL INVESTIGATION
EDINA, MINNESOTA
FOR: MINNESOTA POLLUTION CONTROL AGENCY

Drawn :	TAK	6/30/2008
Checked:	CMD	6/30/2008
Approved:	RLD	6/30/2008
PROJECT NUMBER	200703587	
FIGURE NUMBER	1	



NOTE: DIAGRAM BASED ON PLAN FOUND ON EDINA WEBSITE.

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LAND USE MAP

EDINA WELL INVESTIGATION
EDINA, MINNESOTA
FOR: MINNESOTA POLLUTION CONTROL AGENCY

Drawn:	TAK	6/30/2008
Checked:	CMD	6/30/2008
Approved:	RLD	6/30/2008
PROJECT NUMBER	200703587	
FIGURE NUMBER	2	

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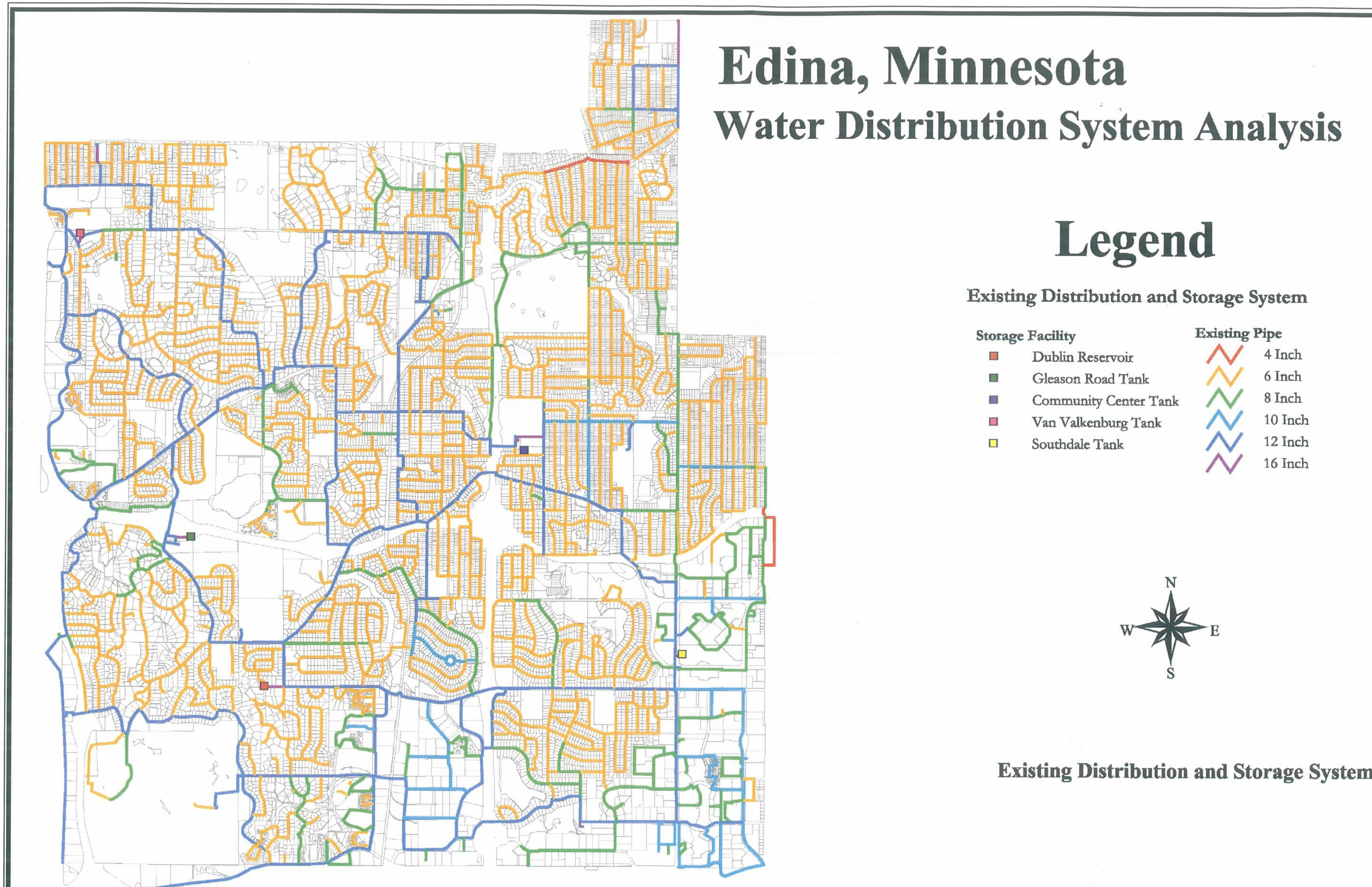

NOTE: DIAGRAM BASED ON PLAN PROVIDED BY SHORT ELLIOT HENDRICKSON.

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WATER DISTRIBUTION SYSTEM

EDINA WELL INVESTIGATION
EDINA, MINNESOTA
FOR: MINNESOTA POLLUTION CONTROL AGENCY

Drawn:	TAK	6/30/2008
Checked:	CMD	6/30/2008
Approved:	RLD	6/30/2008
PROJECT NUMBER	200703587	
FIGURE NUMBER	3	

Table 1 – Interconnection Investigation

Municipality	Municipal System Information *	Infrastructure	Water Chemistry **	Water Pressure	Supply and Demand Capability	Comments
St. Louis Park	• Groundwater resources - 11 wells ranging from 286 to 1095 feet in depth. • Population – 44,126	• 6-8" watermain is present within the neighborhoods adjacent to Edina. • 12" watermain along France Ave. • Requires removal and replacement of existing watermain • SCADA system and telemetry updates	• Water softening is an issue. The mixing of hard water is an issue for the system operators. Water softening will be required to allow for the connection to occur if connection is to be a potable supply of water. • The necessary water treatment is conducted on the source water prior to delivery to the users. Unfiltered/untreated water is an issue	• Pressure reducing controls are required to allow connection. Edina water pressure is considerably higher.	• St. Louis Park has achieved full development. • Water demands are continually met by the City. • Redevelopment is occurring creating a change in system demands, but not affecting system performance	St. Louis Park is a viable option for an interconnection to occur considering similar water resources. Water chemistry and pressure are the issues that must be addressed. Public's perception of St. Louis Park water is a concern.
Richfield	• Groundwater resources – 7 wells ranging from 405 to 1066 feet in depth • Population – 34,439	• Watermain present within neighborhoods and through streets to Edina. • Connect along 66th or 76th Street West with street and utility reconstruction project • SCADA system and telemetry updates	• Water softening is an issue. The mixing of hard water is an issue for the system operators. Water softening will be required to allow for the connection to occur if connection is to be a potable supply of water. • The necessary water treatment is conducted on the source water prior to delivery to the users. Unfiltered/untreated water is an issue	• Pressure reducing controls are required to allow connection. Edina water pressure is considerably higher.	• Richfield has achieved full development. • Water demands are continually met by the City. • Redevelopment is occurring creating a change in system demands, but not effecting system performance	Richfield softens the water supply. The connection here may not be feasible due to the need for costly infrastructure for Edina to soften the water.
Bloomington	• Groundwater and surface water resources • Population – 81,152 • 6 – wells ranging from 376 to 963 feet in depth • Surface water supply – Minneapolis • Water is blended with Minneapolis water in areas of the City	• Connection of watermain exists between Edina and Bloomington along the south/southeast of the City. Commercial properties of Edina are served by Bloomington. • SCADA system and telemetry upgrades	• Water softening is an issue. The mixing of hard water is an issue for the system operators. Water softening will be required to allow for the connection to occur if connection is to be a potable supply of water. • The necessary water treatment is conducted on the source water prior to delivery to the users. Unfiltered/untreated water is an issue	• Pressure reducing controls are required to allow connection. Edina water pressure is considerably higher.	• Bloomington has achieved full development. • Water demands are continually met by the City. • Redevelopment is occurring creating a change in system demands, but not effecting system performance	The water system pressure from Edina is too high and will overcome the water in Bloomington's watermain. Pressure reducing infrastructure will be needed. Bloomington softens and will require a softened water supply to allow for an interconnection.
Hopkins	• Groundwater source – 3 wells ranging from 495 to 548 feet in depth • Population – 16,800	• Watermain is not available for an interconnection to occur. Considerable infrastructure improvement projects would be imposed on Hopkins and Edina.	• Water softening is an issue. The mixing of hard water is an issue for the system operators. Water softening will be required to allow for the connection to occur if connection is to be a potable supply of water. • The necessary water treatment is conducted on the source water prior to delivery to the users. Unfiltered/untreated water is an issue	• Pressure reducing controls are required to allow connection. Edina water pressure is considerably higher.	• Hopkins is a smaller community with an estimated supply of water and infrastructure to service the residents and businesses of the community. The supply capabilities of Hopkins' water system are limited to adjacent users.	For issues associated with supply and demand, an interconnection with Hopkins is not feasible.
Minnetonka	• Groundwater resources – 18 wells ranging in depth from 405 to 575 feet • Population – 49,928	• Watermain is available along the municipal boundary. Infrastructure improvement project required to make connection. • SCADA system and telemetry upgrades	• Water chemistry is consistent with the City of Edina. No softening is conducted. • Water treatment is required on the source water prior to delivery to the users. Unfiltered/untreated water is an issue.	• Pressure reducing controls are required to allow connection. Edina water pressure is considerably higher.	• New land development and redevelopment are occurring, but not affecting system performance.	Minnetonka may serve as a viable connection. Infrastructure systems will be needed to make the connection. Sources supplies are unique and should be considered for potable water supply.
Eden Prairie	• Groundwater resources – wells range 379 to 418 feet in depth • Population – 54,901	• Watermain is available. Infrastructure improvement project to make connection. • Water is supplied to Edina properties along the municipal boundary. Edina owns the watermain. • SCADA system and telemetry upgrades	• Water softening is an issue. The mixing of hard water is an issue for the system operators. Water softening will be required to allow for the connection to occur if connection is to be a potable supply of water. • Water treatment is required on the source water prior to delivery to the users. Unfiltered/untreated water is an issue	• Pressure reducing controls are required to allow connection. Edina water pressure is considerably higher.	• Eden Prairie has achieved full development. • Water demands are continually met by the City. • Redevelopment is occurring creating a change in system demands, but not effecting system performance.	Eden Prairie softens the water supply. The connection here may not be feasible due to the need for costly infrastructure for Edina to soften the water.
Minneapolis	• Surface water resources – Mississippi River • Population – 369,051	• Water is provided to the Morningside Neighborhood of Edina. Watermain is owned by Edina. • SCADA system and telemetry upgrades	• Water softening is an issue. The mixing of hard water is an issue for the system operators. Water softening will be required to allow for the connection to occur if connection is to be a potable supply of water. • Water treatment is required on the source water prior to delivery to the users. Unfiltered/untreated water is an issue	• Pressure reducing controls are required to allow connection. Edina water pressure is considerably higher.	• Minneapolis has achieved full development. • Water demands are continually met by the City. • Redevelopment is occurring creating a change in system demands, but not effecting system performance. • Source supply is not an issue.	Minneapolis may serve as a viable option for an interconnection. Supply and demand capabilities are not an issue, and the City already uses water from the Minneapolis system. Pressure reducing and softening infrastructure will be required.

Table 2 - Estimated Costs of Remedial Alternatives (for 20-year Period)

Edina Well 7 Groundwater Contamination
Focused Feasibility Study
STS Project 200804044

Alternative	Initial RA Cost: (1)	Total O&M Cost:	Total Cost plus 30% Contingency:
<u>1.0 No Active Remediation</u>			
1.1 No Action - Continue Existing Groundwater Quality and Water Level Monitoring Programs	**$5,000**	**$221,000**	**$292,300**
Annual sampling ED wells for VOC, field work (for the next 20 years)		$40,000	
Analytical laboratory costs (low-level VOC analysis, once a year for the next 20 years)		$21,000	
Continuous water level monitoring in three OPCJ monitoring wells (ED-7, ED Test Well, Meadowbrook Well), data maintenance and processing(for the next 20 years)	$5,000	$90,000	
Annual monitoring report - VOC and water level data maintenance, processing and reporting (for the next 20 years)		$70,000	
1.2 Upgrading Monitoring System - Constructionn of Additional Monitoring Wells	**$158,000**	**$260,500**	**$496,650**
Installation of additional three permanent monitoring wells ($50k per well, includes the entire cost of design, bidding, well construction, supervision, initial testing, documentation and reporting)	$150,000		
Annual sampling of ED wells for VOC, field work (for the next 20 years)		$60,000	
Analytical laboratory costs (low-level VOC analysis, once a year for the next 20 years)		$25,500	
Continuous water level monitoring in five OPCJ monitoring wells (ED-7, ED Test Well, Meadowbrook Well and two of the new OPCJ monitoring wells), data maintenance and processing (for the next 20 years)	$8,000	$99,000	
Annual monitoring report - VOC and water level data maintenance, processing and reporting (for the next 20 years)		$76,000	
<u>2.0 Construction of Additional Municipal Wells / Changing Configuration of Pumping / Creation of Hydraulic Barrier</u>			
2.1 Construction of ED-21	**$650,000**	**$0**	**$650,000**
Well construction and installation of pump	$300,000		
Phase II - well building and connection, electircal and mechanical systems, landscaping	$350,000		
2.2 Changing Configuration of Pumping / Creation of Hydraulic Barrier **Cost of different pumping configurations beyond the cost of construction and operation of ED-21 and operation of the current water supply system**			
2.2.1 Pumping Configurations (Model Predicitve Simulations) No. 1, 2, 3, 7 and 8	**$0**	**$0**	**$0**
2.2.4 Pumping Configuration (Model Predicitve Simulation) No. 4	**$8,000**	**$152,000**	**$205,600**
Operating SLP-6, handling/disposal of SLP-6 produced contaminated groundwater	$8,000	$152,000	
2.2.5 Pumping Configuration (Model Predicitve Simulation) No. 5	**$56,000**	**$240,000**	**$368,000**
Installation of pump in Meadowbrook Well	$50,000	$120,000	
Operating Meadowbrook Well, handling/disposal of the Meadowbrook Well's produced contaminated groundwater	$6,000	$120,000	
2.2.6 Pumping Configurations (Model Predicitve Simulations) No. 6, 9 and 10	**$63,600**	**$272,000**	**$417,200**
Installation of pump in Meadowbrook Well	$50,000		
Operating Meadowbrook Well, handling/disposal of the Meadowbrook Well's produced contaminated groundwater	$6,000	$120,000	
Operating SLP-6, handling/disposal of SLP-6 produced contaminated groundwater	$7,600	$152,000	
<u>3.0 Construction and Operation of Water Treatment Plant(s)</u>			
3.1 **Construction of New Treatment Facility - (1 Facility)**	**$1,980,000**	**$550,000**	**$2,695,000**
Design and Construction	$1,980,000		
Control Integration		$150,000	

Table 2 - Estimated Costs of Remedial Alternatives
(for 20-year Period)

Edina Well 7 Groundwater Contamination
Focused Feasibility Study
STS Project 200804044

Alternative		Initial RA Cost: (1)	Total O&M Cost:	Total Cost plus 30% Contingency:
	Operation and Maintenance		$400,000	
3.2	**Upgrade to Existing Treatment Facility - (1 Facility)**	**$600,000**	**$550,000**	**$1,315,000**
	Supply and Installation of Treatment Systems and Controls	$500,000		
	Control Integration		$150,000	
	Operation and Maintenance		$400,000	
	Facility Expansion (Building Addition)	$100,000		
4.0	**Purchasing Water from Neighboring Cities, Construction of Interconnected Mains***	**$670,000**	**$1,904,000**	**$3,145,200**
	Adjacent Municipality - All Municipalities			
	Interconnection Study	$70,000	$0	
	Design and Development	$100,000	$0	
	Construction and Controls and Integration	$500,000	$0	
	Water Use and Operation (20 years)	N/A	$1,904,000	

Notes:

(1) Table 2 includes only the costs in addition to and beyond the operation and maintenance costs of the current systems (City of Edina's water supply system and ongoing monitoring programs operated by the City of St. Louis Park, MPCA and MDH)

Table 2A - Estimated Cost of Water Treatment Plant with Activated Carbon Installation
(for 20-year Period)
Activated Carbon

Edina Well 7 Groundwater Contamination
Focused Feasibility Study
STS Project 200804044

	Alternative	Initial RA Cost: (1)	Total O&M Cost:	Total Cost plus 30% Contingency:
	<u>1.0 Construction and Operation of Water Treatment Plant(s)</u>			
1.1	**Construction of New Treatment Facility - (Activated Carbon) - (1 Facility)**	**$2,020,000**	**$1,150,000**	**$3,515,000**
	Design and Construction	$2,020,000		
	Control Integration		$150,000	
	Operation and Maintenance (Backwashing & Carbon Replacement)		$1,000,000	
1.2	**Upgrade to Existing Treatment Facility - (Activated Carbon) - (1 Facility)**	**$300,000**	**$1,150,000**	**$1,795,000**
	Supply and Installation of Treatment Systems and Controls	$200,000		
	Control Integration		$150,000	
	Operation and Maintenance (Backwashing and Carbon Replacement)		$1,000,000	
	Facility Expansion (Building Addition)	$100,000		

Table 2A - Estimated Cost of Water Treatment Plant with Activated Carbon Installation
(for 20-year Period)
Activated Carbon

Edina Well 7 Groundwater Contamination
Focused Feasibility Study
STS Project 200804044

	Alternative	Initial RA Cost: (1)	Total O&M Cost:	Total Cost plus 30% Contingency:
	1.0 Construction and Operation of Water Treatment Plant(s)			
1.1	**Construction of New Treatment Facility - (Activated Carbon) - (1 Facility)**	**$2,020,000**	**$1,150,000**	**$3,515,000**
	Design and Construction	$2,020,000		
	Control Integration		$150,000	
	Operation and Maintenance (Backwashing & Carbon Replacement)		$1,000,000	
1.2	**Upgrade to Existing Treatment Facility - (Activated Carbon) - (1 Facility)**	**$300,000**	**$1,150,000**	**$1,795,000**
	Supply and Installation of Treatment Systems and Controls	$200,000		
	Control Integration		$150,000	
	Operation and Maintenance (Backwashing and Carbon Replacement)		$1,000,000	
	Facility Expansion (Building Addition)	$100,000		

Table 3A - Summary of Response Action Options
Threshold Criteria

Edina Well 7 Groundwater Contamination
Focused Feasibility Study
STS Project 200804044

Option	Overall Protection of Human Health	Compliance with ARARs
No Active Remediation		
No Action - Continue Existing Groundwater Quality and Water Level Monitoring Programs	Protective	Maybe
Upgrading Monitoring System - Constructionn of Additional Monitoring Wells	Protective	Maybe
Construction of Additional Municipal Wells / Changing Configuration of Pumping / Creation of Hydraulic Barrier		
Pumping Configuration (Model Predictive Simulation) No. 1	Protective	Maybe
Pumping Configuration (Model Predictive Simulation) No. 2	Protective	Maybe
Pumping Configuration (Model Predictive Simulation) No. 3	Protective	Maybe
Pumping Configuration (Model Predictive Simulation) No. 4	Protective	Maybe
Pumping Configuration (Model Predictive Simulation) No. 5	Protective	Maybe
Pumping Configuration (Model Predictive Simulation) No. 6	Protective	Maybe
Pumping Configuration (Model Predictive Simulation) No. 7	Protective	Maybe
Pumping Configuration (Model Predictive Simulation) No. 8	Protective	Maybe
Pumping Configuration (Model Predictive Simulation) No. 9	Protective	Maybe
Pumping Configuration (Model Predictive Simulation) No. 10	Protective	Maybe

Table 3A - Summary of Response Action Options
Threshold Criteria

Edina Well 7 Groundwater Contamination
Focused Feasibility Study
STS Project 200804044

Option	Overall Protection of Human Health	Compliance with ARARs
Construction and Operation of Water Treatment Plant(s)		
Design and Develop New Treatment Facility	Protective	Yes
Upgrade Existing Treatment Facility with New Treatment Techniques	Protective	Yes
Purchasing Water from Neighboring Cities, Construction of Interconnected Mains		
St. Louis Park	Protective	Maybe
Richfield	Protective	Yes
Bloomington	Protective	Yes
Hopkins	Protective	Yes
Minnetonka	Protective	Yes
Eden Prairie	Protective	Yes
Minneapolis	Protective	Yes

Table 3B - Summary of Response Action Options
Balancing Criteria

Option	Implementability		Cost		Long-term Effectiveness		Time to Remediate		Short-term Risks		Reduction of TMV		State Acceptance		Community Acceptance		Compliance with ARARs		Total Score (*)	Evaluation Results
No Active Remediation																				
No Action - Continue Existing Groundwater Quality and Water Level Monitoring Programs	Easy - No action required	5	Low	5	Low	1	Decades	1	Moderate to High	2	None, None, None	0	No	1	No	1	Maybe	3	19	Not Recommended
Upgrading Monitoring System - Constructionn of Additional Monitoring Wells	Easy to Moderate	4	Low to Moderate	5	Low	1	Decades	1	Moderate to High	2	None, None, None	0	Yes	5	Yes	5	Maybe	3	26	Recommended as supplementary to active remedial actions
Construction of Additional Municipal Wells / Changing Configuration of Pumping / Creation of Hydraulic Barrier																				
Pumping Configuration (Model Predictive Simulation) No. 1	Easy - No action required	5	Low	5	Low	1	Decades	1	Moderate to High	2	None, Moderate, None	1	No	1	No	1	Maybe	3	20	Not Recommended - does not address ED-2 and ED-13 contamination
Pumping Configuration (Model Predictive Simulation) No. 2	Easy to Moderate	4	Moderate	3	Low	1	Decades	1	Moderate to High	2	None, Moderate, None	1	No	1	Maybe	3	Maybe	3	19	Not Recommended - ED-21 located at Garden Park may pull in VOC contaminants and this option does not address ED-2 and ED-13 contamination
Pumping Configuration (Model Predictive Simulation) No. 3	Easy to Moderate	4	Moderate	3	Low	1	Decades	1	Moderate to High	2	None, None, None	0	No	1	Maybe	3	Maybe	3	18	Not Recommended - ED-21 located at Birch Chest Park is safer than at Garden Park but does not address ED-2 and ED-13 contamination
Pumping Configuration (Model Predictive Simulation) No. 4	Moderate to difficult - would involve pumping from SLP-6	2	Moderate to High	2	Moderate	3	Decades	1	Moderate	3	None, Moderate, None	1	Yes	5	Maybe	3	Maybe	3	23	Feasible - depending on arrangements with the City of St. Louis Park
Pumping Configuration (Model Predictive Simulation) No. 5	Moderate to difficult - would involve pumping from	2	Moderate to High	2	Moderate	3	Decades	1	Moderate	3	None, Moderate, None	1	Yes	5	Maybe	3	Maybe	3	23	Feasible - depending on arrangements with the City of Minneapolis (Meadowbrook Golf Course)
Pumping Configuration (Model Predictive Simulation) No. 6	Moderate to difficult - would involve pumping from SLP-6 and Meadowbrook Well	2	High	1	Moderate to High	4	Decades	1	Low to Moderate	4	None, Moderate, None	1	Yes	5	Maybe	3	Maybe	3	24	Feasible - depending on arrangements with the City of St. Louis Park and the City of Minneapolis (Meadowbrook Golf Course)
Pumping Configuration (Model Predictive Simulation) No. 7	Easy to Moderate	4	Moderate	3	Low	1	Decades	1	Moderate to High	2	None, None, None	0	No	1	No	1	Maybe	3	16	Not Feasible - this pumping configuration would likely result in pulling VOC plume toward other Edina municipal wells
Pumping Configuration (Model Predictive Simulation) No. 8	Easy to Moderate	4	Moderate	3	Low	1	Decades	1	Moderate to High	2	None, None, None	0	No	1	No	1	Maybe	3	16	Not Feasible - this pumping configuration would likely result in pulling VOC plume toward other Edina municipal wells
Pumping Configuration (Model Predictive Simulation) No. 9	Moderate to difficult - would involve pumping from SLP-6 and Meadowbrook Well	2	High	1	Moderate to High	4	Decades	1	Low to moderate	4	None, None, None	0	Yes	5	Maybe	3	Maybe	3	23	Feasible - depending on arrangements with the City of St. Louis Park and the City of Minneapolis (Meadowbrook Golf Course)
Pumping Configuration (Model Predictive Simulation) No. 10	Easy to Moderate	4	Moderate	3	Low	1	Decades	1	Moderate to High	2	None, None, None	0	No	1	No	1	Maybe	3	16	Not Feasible - this pumping configuration would likely result in pulling VOC plume toward other Edina municipal wells

Table 3B - Summary of Response Action Options
Balancing Criteria

Option	Implementability		Cost		Long-term Effectiveness		Time to Remediate		Short-term Risks		Reduction of TMV		State Acceptance		Community Acceptance		Compliance with ARARs		Total Score (*)	Evaluation Results
Construction and Operation of Water Treatment Plant(s)																				
Design and Develop New Treatment Facility	Moderate to Difficult	2	High	1	High	5	Years	3	Low	5	High, Mod, Mod	4	Yes	5	Yes	5	Yes	5	35	Feasible - Water treatment is a viable option. New construction will require further study and investigation of best suited location and treatment techniques
Upgrade Existing Treatment Facility with New Treatment Techniques	Moderate to Difficult	2	High	1	High	5	Months to Years	4	Low	5	High, Mod, Mod	4	Yes	5	Yes	5	Yes	5	36	Most Feasible - Existing facilities will require further evaluation for construction of new systems. Ability to integrate new systems will dictate the implementability of this option.
Purchasing Water from Neighboring Cities, Construction of Interconnected Mains																				
St. Louis Park	Difficult	1	High	1	Moderate	3	Years	3	Moderate	3	None, None, None	0	Maybe	3	No	1	Maybe	3	18	Feasilbe - Considerable time for evaluation. Infrastructure improvements will be necessary. Community acceptance may be an issue
Richfield	Difficult	1	High	1	Moderate	3	Years to Decades	2	Moderate	3	None, None, None	0	Maybe	3	Maybe	3	Yes	5	21	Not Recommended at this time - Major infrastructure improvements are required. Water Chemistry is a major concern.
Bloomington	Moderate	3	Moderate to High	2	Moderate	3	Years	3	Moderate	3	None, None, None	0	Maybe	3	Maybe	3	Yes	5	25	Feasilbe - Considerable time for evaluation. Minimal infrastructure improvements. Bloomington is serviced by Minneapolis. Water softening is a major concern
Hopkins	Difficult	1	Very High	0	Low	1	Years to Decades	2	Moderate	3	None, None, None	0	Maybe	3	No	1	Yes	5	16	Not Feasible - Too great of an infrastructure improvement project necessary to provide connection
Minnetonka	Moderate to Difficult	2	Moderate to High	2	Moderate	3	Years	3	Moderate	3	None, None, None	0	Maybe	3	Maybe	3	Yes	5	24	Feasible - Infrastructure exists with some improvements. Water quality is consistent with Edina.
Eden Prairie	Moderate	3	Moderate to High	2	Moderate	3	Years	3	Moderate	3	None, None, None	0	Maybe	3	Maybe	3	Yes	5	25	Feasible - Edina residents are serviced by Eden Praire. Some infrastrucutre improvements required. Water chemistry is an issue.
Minneapolis	Moderate	3	Moderate	3	Moderate	3	Years	3	Moderate	3	None, None, None	0	Maybe	3	Maybe	3	Yes	5	26	Most Feasible - Morningside Neighborhood is service by Minneapolis water. Minimal infrastructure to make connection. Appears to be the appropriate municipal connection.

(*) - Score Points:

Implementability	Easy = 5; Easy to Moderate = 4; Moderate = 3; Moderate to Difficult = 2; Difficult = 1
Cost	Low = 5; Low to Moderate = 4; Moderate = 3; Moderate to High = 2; High = 1; Very High = 0
Long-term Effectiveness	High = 5; Moderate to High = 4; Moderate = 3; Low to Moderate = 2, Low = 1
Time to Remediate	Months = 5; Months to Years = 4; Years = 3, Years to Decades = 2; Decades = 1
Short-term Risks	Low = 5; Low to Moderate = 4; Moderate = 3; Moderate to High = 2; High = 1

Reduction of TMV (Toxicity, Mobility or Volume):

Reduction in Toxicity	High = 2; Moderate = 1; None = 0
Reduction in Mobility	High = 2; Moderate = 1; None = 0
Reduction in Volume	High = 2; Moderate = 1; None = 0
State Acceptance	Yes = 5, Maybe = 3; No = 1
Community Acceptance	Yes = 5, Maybe = 3; No = 1
Compliance with ARARs	Yes = 5, Maybe = 3; No = 1

Table 4 - Recommended Remedial Action Options

Edina Well 7 Groundwater Contamination
Focused Feasibility Study
STS Project 200804044

Option	Total Score (*)	Evaluation Results
Upgrade Existing Treatment Facility with New Treatment Techniques	**36**	**Upgrading the existing treatment facility is a viable and the first recommended option. Existing facilities will require further evaluation for construction of new systems. Ability to integrate new systems will dictate the level fo difficulty in implementing this option.**
Design and Develop New Treatment Facility	**35**	**Construction of a new treatment facility is the second recommended option. Construction of new facility construction will require further study and investigation of best suited location and treatment techniques**
Upgrading Monitoring System - Constructionn of Additional Monitoring Wells	**26**	**Upgrading and operating a monitoring system is recommended in addition to a selected remedial option**
Purchasing Water from Neighboring Cities, Construction of Interconnected Mains	**18 - 26**	**Purchasing water from either Minneapolis, Bloomington or Eden Prairie is a feasible remedial option. However, this is not a complete option - maintenance of hydraulic barrier in OPCJ aquifer between St. Louis Park and Edina would still be necessary to prevent expansion of VOC plume and contaminating more Edina wells**

Notes:

(*) - Score Points from Table 3B

Table 5 Puming Wells Represented in the Model - Predictive Simulations

Reilly Tar Site /
Meadowbrook Ground Water Model Update/Recallibration
STS Project No. 200703587

		Pumping Rates Used in Predictive Simulations 1 - 10 (m^3/day)									
Well Name	MN Unique No.	1	2	3	4	5	6	7	8	9	10
ABBOTT_NW_HOSP_1	00201082	-2065	-2065	-2065	-2065	-2065	-2065	-2065	-2065	-2065	-2065
ABBOTT_NW_HOSP_2	00201083	-1199	-1199	-1199	-1199	-1199	-1199	-1199	-1199	-1199	-1199
ABBOTT_NW_HOSP_3	00112248	-539	-539	-539	-539	-539	-539	-539	-539	-539	-539
EDINA_13	00203613	-4770	-4770	-4770	-4770	-4770	-4770	0	-4770	-4770	0
EDINA_15	00207674	-805	-805	-805	-805	-805	-805	0	0	0	0
EDINA_16	00203101	-1732	-1732	-1732	-1732	-1732	-1732	-6501	-2537	-2537	-5138
EDINA_17	00200914	-112	-112	-112	-112	-112	-112	-112	-112	-112	-112
EDINA_2	00208399	-3407	-3407	-3407	-3407	-3407	-3407	0	0	0	0
EDINA_4	00200561	-767	-767	-767	-767	-767	-767	-767	-767	-767	-767
EDINA_6	00200564	-3255	-3255	-3255	-3255	-3255	-3255	-3255	-3255	-3255	-3255
EDINA_7	00206474	0	0	0	0	0	0	0	0	0	0
EDINA_20	new well (under construction)	–	-754	-754	-754	-754	-754	-4161	-754	-754	-1560
EDINA_21	future new well - Garden Park location	–	-860	–	–	–	–	–	–	–	–
EDINA_21A	future new well - Birch Chest Park location	–	–	-860	-860	-860	-860	-860	-860	-860	-860
GM_1	00224098	-1566	-1566	-1566	-1566	-1566	-1566	-1566	-1566	-1566	-1566
GM_3	00226208	-870	-870	-870	-870	-870	-870	-870	-870	-870	-870
GM_4	00161405	-779	-779	-779	-779	-779	-779	-779	-779	-779	-779
GM_OP_1	00223780	-212	-212	-212	-212	-212	-212	-212	-212	-212	-212
HINES_1	00201007	0	0	0	0	0	0	0	0	0	0
HONEYWELL_INC_1	00203892	-1662	-1662	-1662	-1662	-1662	-1662	-1662	-1662	-1662	-1662
HONEYWELL_INC_2	00203878	-703	-703	-703	-703	-703	-703	-703	-703	-703	-703
HOPKINS_1	00204573	0	0	0	0	0	0	0	0	0	0
HOPKINS_4	00204068	-7999	-7999	-7999	-7999	-7999	-7999	-7999	-7999	-7999	-7999
HOPKINS_5	00204570	-234	-234	-234	-234	-234	-234	-234	-234	-234	-234
HOPKINS_6	00112228	-1317	-1317	-1317	-1317	-1317	-1317	-1317	-1317	-1317	-1317
MINNETONKA_10	00204140	-1773	-1773	-1773	-1773	-1773	-1773	-1773	-1773	-1773	-1773
MINNETONKA_10A	00150356	-1647	-1647	-1647	-1647	-1647	-1647	-1647	-1647	-1647	-1647
MINNETONKA_11	00208014	-2411	-2411	-2411	-2411	-2411	-2411	-2411	-2411	-2411	-2411
MINNETONKA_11A	00439797	-2888	-2888	-2888	-2888	-2888	-2888	-2888	-2888	-2888	-2888
MINNETONKA_12	00203717	-2663	-2663	-2663	-2663	-2663	-2663	-2663	-2663	-2663	-2663
MINNETONKA_12A	00191939	-2452	-2452	-2452	-2452	-2452	-2452	-2452	-2452	-2452	-2452
MINNETONKA_13	00205165	-3612	-3612	-3612	-3612	-3612	-3612	-3612	-3612	-3612	-3612
MINNETONKA_13A	00132263	-2795	-2795	-2795	-2795	-2795	-2795	-2795	-2795	-2795	-2795
MINNETONKA_14	00204537	-976	-976	-976	-976	-976	-976	-976	-976	-976	-976
MINNETONKA_14A	00160021	-612	-612	-612	-612	-612	-612	-612	-612	-612	-612
MINNETONKA_3	00204470	-421	-421	-421	-421	-421	-421	-421	-421	-421	-421
MINNETONKA_3A	00171021	-783	-783	-783	-783	-783	-783	-783	-783	-783	-783
MINNETONKA_6	00204054	-2898	-2898	-2898	-2898	-2898	-2898	-2898	-2898	-2898	-2898
MINNETONKA_7	00208012	-1734	-1734	-1734	-1734	-1734	-1734	-1734	-1734	-1734	-1734
NSP_XCEL_EN_1	00200362	-805	-805	-805	-805	-805	-805	-805	-805	-805	-805
PLYMOUTH_12	00508300	-2320	-2320	-2320	-2320	-2320	-2320	-2320	-2320	-2320	-2320
PLYMOUTH_13	00462918	-3101	-3101	-3101	-3101	-3101	-3101	-3101	-3101	-3101	-3101
PLYMOUTH_7	00184882	-2908	-2908	-2908	-2908	-2908	-2908	-2908	-2908	-2908	-2908
REPUBLIC_CEROSOTE_(W23)	00216050	-253	-253	-253	-253	-253	-253	-253	-253	-253	-253
RICHFIELD_1	00206353	-2629	-2629	-2629	-2629	-2629	-2629	-2629	-2629	-2629	-2629
RICHFIELD_2	00206353	-1758	-1758	-1758	-1758	-1758	-1758	-1758	-1758	-1758	-1758
RICHFIELD_3	00206361	-2374	-2374	-2374	-2374	-2374	-2374	-2374	-2374	-2374	-2374
RICHFIELD_4	00206276	-2080	-2080	-2080	-2080	-2080	-2080	-2080	-2080	-2080	-2080
RICHFIELD_6	00206279	-1782	-1782	-1782	-1782	-1782	-1782	-1782	-1782	-1782	-1782
SLP_10	00206442	-3210	-3210	-3210	-3210	-3210	-3210	-3210	-3210	-3210	-3210
SLP_14	00227965	-3470	-3470	-3470	-3470	-3470	-3470	-3470	-3470	-3470	-3470
SLP_16	00203187	-1992	-1992	-1992	-1992	-1992	-1992	-1992	-1992	-1992	-1992
SLP_4	00200542	-5096	-5096	-5096	-5096	-5096	-5096	-5096	-5096	-5096	-5096
SLP_6	00206457	0	0	0	-2078	0	-2078	0	0	-2078	-2078
SLP_8	00203678	-4854	-4854	-4854	-4854	-4854	-4854	-4854	-4854	-4854	-4854
W410	00434042	-464	-464	-464	-464	-464	-464	-464	-464	-464	-464
W420	00434045	-181	-181	-181	-181	-181	-181	-181	-181	-181	-181
W421	00434044	-161	-161	-161	-161	-161	-161	-161	-161	-161	-161
W439	?	-264	-264	-264	-264	-264	-264	-264	-264	-264	-264
W434	00463012	-177	-177	-177	-177	-177	-177	-177	-177	-177	-177
MEADOWBROOK_W119	00216009	0	0	0	0	-1635	-1635	0	0	-1635	-1635
METHODIST_W48	00216067	0	0	0	0	0	0	0	0	0	0

Notes:

The wells for which pumping rates were varied during predictive simulations, compared to predictive simulation No. 1 (baseline simulation)

Figure 4. Baseline Model Predictive Simulation (Simulation No. 1)

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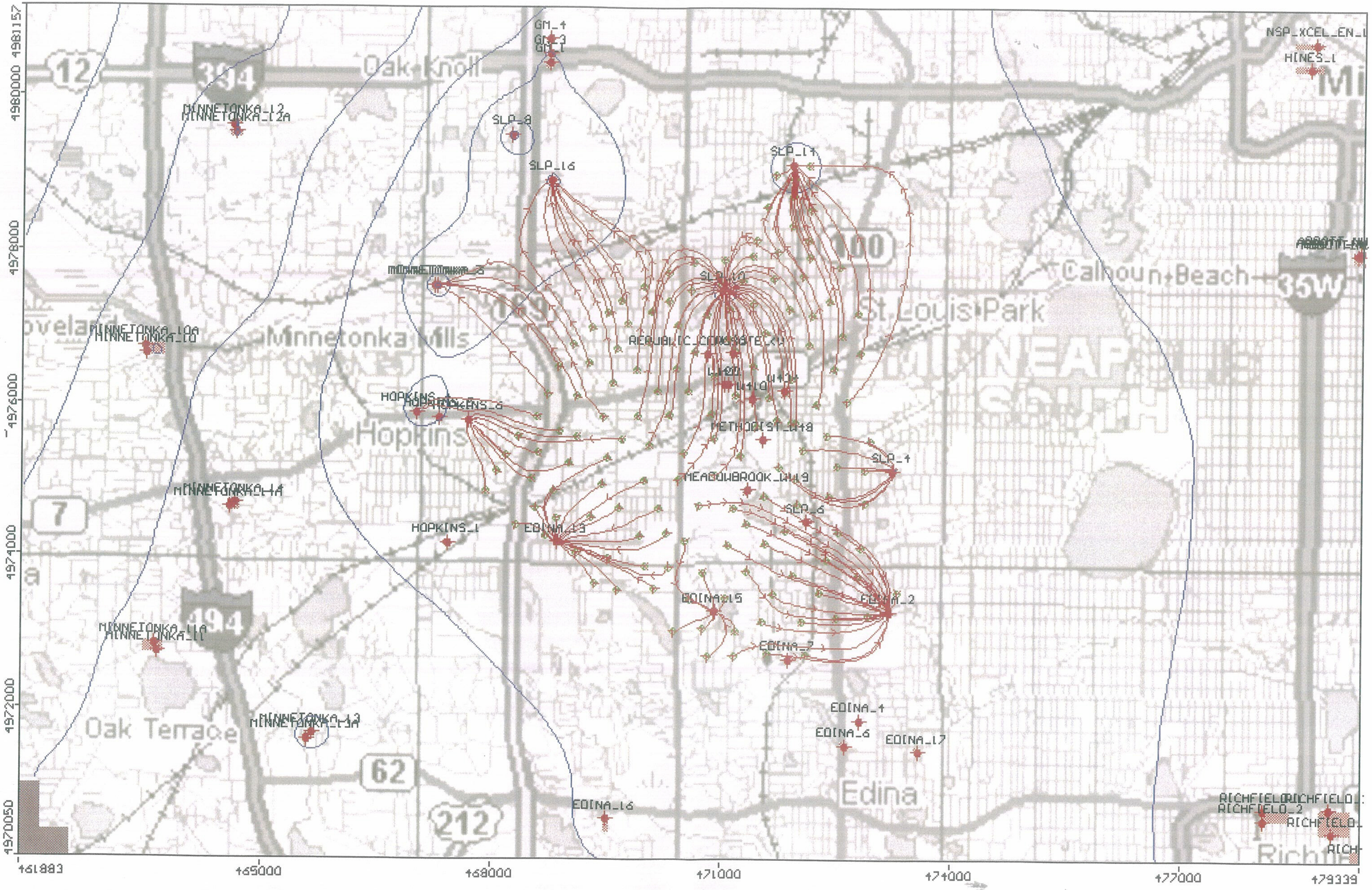

Figure 10. Model Predictive Simulation No. 7

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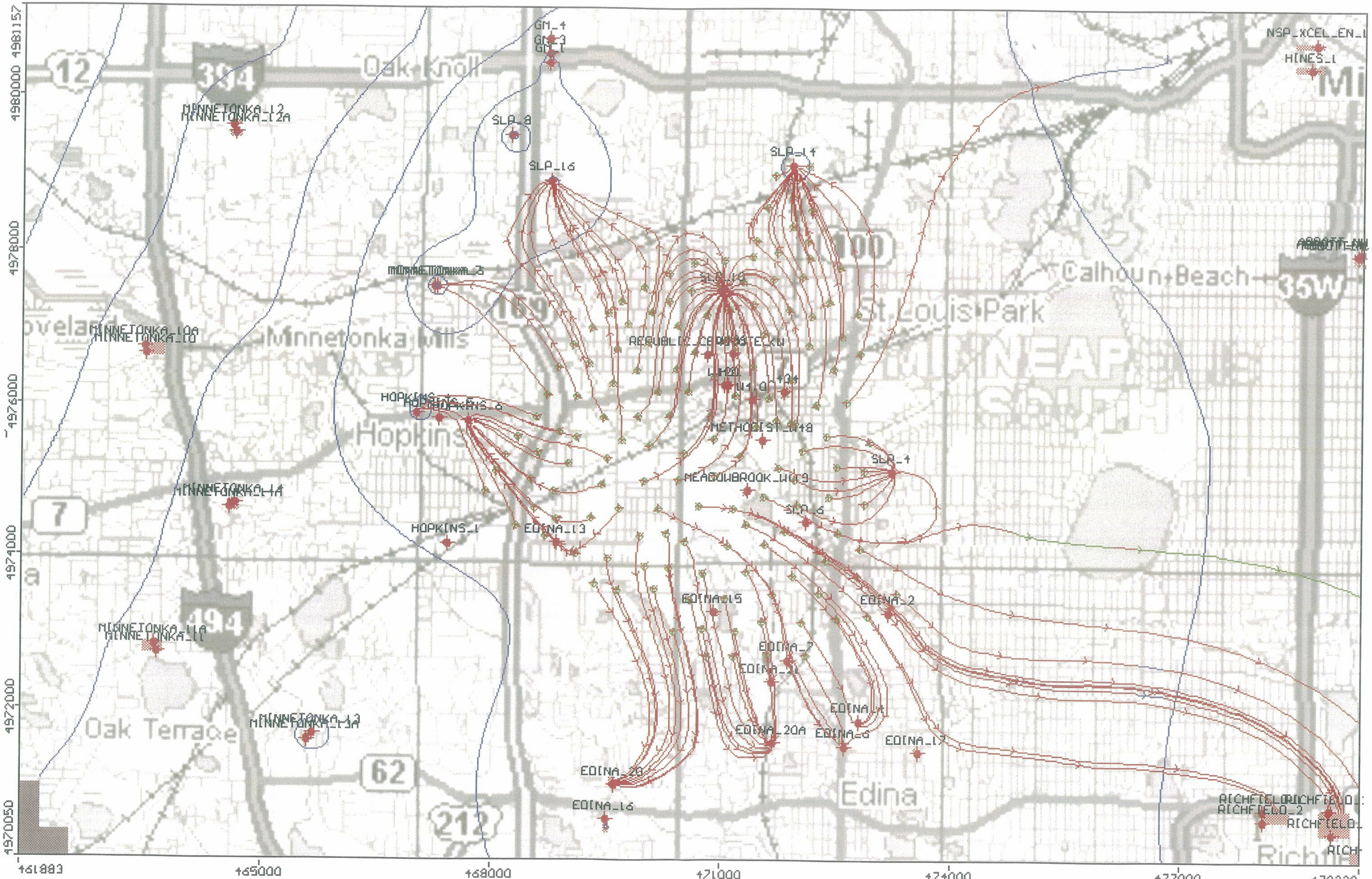

Figure 13. Model Predictive Simulation No. 10

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